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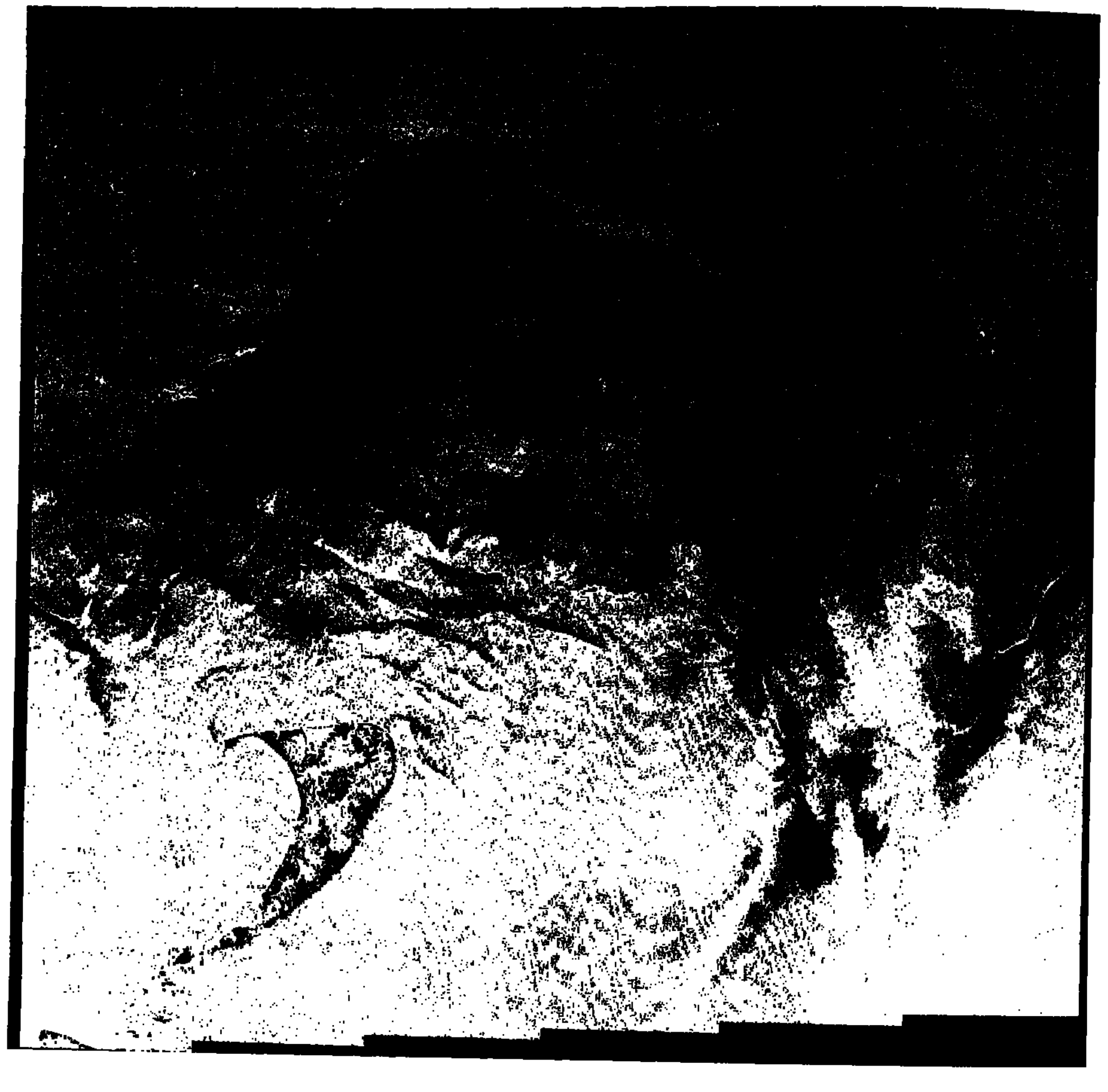


The Oceanography Report, page 618

Transactions, American Geophysical Union Vol. 64, No. 44, Pages 617–624 November 1, 1983

Meteorology

Oceanography

Particles and Fields—Magnetosphere

News

New Observations From ISEE-3

On June 30, 1983, the International Sun-Earth Explorer-3 spacecraft (ISEE-3) was at an apogee of 236 earth radii (R_E) exploring particle and field phenomena in the earth's distant magnetic tail region. Most of what we know about the earth's magnetotail is based on spacecraft observations made inside of the lunar orbit distance (approximately 60 R_E), and a few brief passes of several interplanetary spacecraft through the more distant tail. ISEE-3 is greatly extending the exploration of the geotail by spending a large part of 1983 in the earth's magnetic tail between 60 and 240 R_E.

There will be a special session at the 1983 AGU Fall Meeting which will focus on the new geotail results. In December, ISEE-3 will make a final lunar swing-by, coming within 100 km of the surface of the moon. This maneuver will propel ISEE-3 out into the solar system, where it will pass through the tail of comet Giacobini-Zinner in early September 1985. Later, in March-April 1986, ISEE-3 will monitor the solar wind conditions near Halley's comet while other spacecraft from around the world get a close-up view. ISEE-3 celebrated the fifth anniversary of its launch on August 12.

Normally, for a spacecraft in orbit about the earth, apogee precesses from the sunward side of the earth to the antisunward side and back during the course of one year. ISEE-3, however, has used two lunar swing-bys to offset this natural precession and thus has increased the time available for studying the geotail. ISEE-3 was at an apogee of 221 R_E in the geotail on February 8. Then, on March 30, it was maneuvered into its first encounter with the moon (S1 in the cover figure) which put it into an orbit with apogee at 81 R_E (A2). Precession of this new orbit, plus motion of the moon in its own orbit, allowed the second lunar swing-by (S2) on April 23, sending ISEE-3 back out into the distant geotail. This technique, inaugurated by this mission, was developed by Robert Farquhar of the Goddard Space Flight Center.

Analysis of the geotail data from ISEE-3 is still in its early stages, but interesting features have already been observed. Data from the magnetic field experiment (Jet Propulsion Laboratory (JPL)/University of California, Los Angeles/Brigham Young University) and the electron plasma experiment (Los Alamos National Laboratory/Sandia Laboratories) reveal that all of the major magnetotail field and plasma regimes identified previously by near-earth measurements (e.g., low beta magnetic lobes separated by a plasma sheet in which a neutral sheet is embedded) remain recognizable entities in the distant tail. However, transitions from one regime to another are observed more frequently than near the earth. The JPL and Los Alamos groups currently favor different explanations for this; the JPL group suggests that the frequent transitions are due predominantly to back and forth motion of the deep tail, while the Los Alamos group suggests that the deep tail may be exhibiting a transition to a filamentary structure. Data from all three ISEE spacecraft will be studied during the next year to help define the large-scale structure of the geotail and to resolve this question.

The JPL magnetometer group finds that their observations suggest the following features of the deep tail: (1) two distinct lobes with steady, quiet, solar and antisolar directed fields, separated by (2) a neutral sheet embedded in (3) the plasma sheet and its (4) boundary layers and (5) the magnetopause boundary layer. Tail flaring ceases beyond a distance of 100 to 120 R_E, where the tail flux appears to become constant. Multiple magnetopause boundary crossings are consistent with tailward moving waves of amplitude less than 1 R_E and wavelengths of ~60–180 R_E, probably caused by typical solar-wind flow direction and pressure variations and/or Kelvin-Helmholtz instability. In addition, multiple neutral sheet crossings are often observed. The periods of the oscillations range from 5 to 25 minutes and their wavelengths are thus on the order of 20 to 80 R_E.

In contrast, the Los Alamos group believes that flapping of the tail is probably not the origin of all of the observed variability. Rather, their initial interpretation is that the distant tail may be by nature highly structured, perhaps reminiscent of the visible structure of many ionic comet tails. This structure could be interpreted in terms of a filamentary tail, a "magnetospheric wake," tail breakup and reconnection phenomena, or possibly other processes.

Fundamental new features have been detected in the magnetic field data in and near the plasma sheet and its boundary layers. Significant southward fields with negative By components are detected in the plasma sheet at distances beyond 100 R_E to apogee, 240 R_E. These permanent features of the tail are not currently understood and theoretical models are being explored. Compressive, solitary MHD waves, probably propagating in the fast mode, have been detected in the tail lobes. Passage of the waves leaves the field tilted in towards the neutral sheet and is followed by a slight depression of the field magnitude lasting about an hour. Such effects may be rarefaction waves which are associated with flux removal from the tail. Large amplitude (5 nanotesla), coherent ion-cyclotron waves have been detected near the plasma sheet boundary layers.

The emissions are left hand circularly polarized in the spacecraft frame and propagate along the magnetic field direction. The possibility that these emissions are generated by streaming anisotropic protons is currently being explored. The magnetic field signature of bubbles or plasmoids is also frequently observed within the plasma sheet, usually near the plasma sheet boundary layers. These bubbles are believed to be the result of magnetic field merging within the magnetotail and may propagate either tailward or earthward.

Earthward flow of electrons within the plasma sheet has been observed occasionally by the Los Alamos group, suggesting the temporary presence of a neutral line, i.e., magnetic reconnection region, beyond 220 R_E. Most of the time, however, these electrons are observed to be flowing down the tail, away from the earth with mean velocity of about 500 km s^{-1}. This is considerably higher than is usually observed within the quiet-time, near-earth plasma sheet. The plasma velocity has also been inferred by the Max Planck Institute/University of Maryland group, based on measurements of suprathermal ions. Assuming that these ions are convected with the plasma sheet thermal plasma, they find that the velocity increases with increasing distance from the earth from a value of ~200 km s^{-1} at 70 R_E to >400 km s^{-1} at ~200 R_E. The He++/H+ ratio at equal energy/charge has been observed by this same group to be about 3% to 6% in the plasma sheet. This is lower by a factor of 2 to 3 than that typically observed in the boundary layer and plasma sheet boundaries. The energetic particle anisotropy spectrometer (Imperial College/ESTeC/Utrecht) measures the flow of suprathermal ions with charge ≥ 1 in the energy range 35–1600 keV. The Imperial College group finds that the highest fluxes of energetic ions are found in the plasma sheet (~10–100/(keV s cm² sr) at 35–56 keV). These ions stream away from the earth except at times of earthward plasma flow when earthward ion streaming is observed.

Ion intensities are found to typically be an order of magnitude lower in the boundary layer and lobe regions where "pancake-like" pitch-angle distributions occur, the ions having pitch angles close to 90° with respect to the magnetic field direction. This distribution may be produced if field lines in these regions are open to the interplanetary magnetic field, allowing ions with small pitch angles to escape rapidly from the tail. In the magnetosheath and occasionally in the boundary layer, burst-like ion enhancements with durations of around 10 minutes and exhibiting strong streaming from the earth are observed. These enhancements do not appear to be associated with structure in the tail plasma, suggesting that they are not the result of a plasma filament including high fluxes of energetic ions flapping past the spacecraft. The energy spectra of the suprathermal ions do not vary significantly between plasma regions in the tail.

The Los Alamos group reports observing rotations of the electron bulk flow, reminiscent of plasma vortices, in the distant tail with rotation periods (5–10 minutes) and directions of rotation similar to those found in near-earth measurements. Another discovery by the Los Alamos group is that the electron velocity distributions in the distant tail are commonly bi-directional in all regions except the lobes. A similar bi-directionality is sometimes observed in the near-earth tail, most commonly at the outer edge of the plasma sheet, but is relatively infrequent. Although electron bi-directionality is commonly interpreted as evidence for closed field lines, it is not currently clear that this is the only interpretation for the deep tail. In particular, beyond 180 R_E the plasma wave experiment (TRW/University of Iowa/JPL) measured a dramatic increase in plasma turbulence as reflected in electric field measurements in the few hundred Hz to 2 kHz frequency range.

Comparison with the electron plasma data shows that this turbulence occurs in the plasma-sheet boundary layer and is rather well correlated with bi-directional electron anisotropies. The associated waves are very likely Doppler-shifted ion acoustic waves, although they could also be harmonics of the electron cyclotron frequency. The plasma wave experimenters also report time structure in the electric field continuum at higher frequencies (5–15 kHz), which is reminiscent of solar type III bursts. It is possible that, as in the case of type III bursts, beams of electrons are stimulating this continuum-type emission. By contrast, the continuum emission observed by the TRW group at Jupiter is fairly constant in time.

This news item was contributed by Tycho von Rosenvinge, *who is with the NASA Goddard Space Flight Center, Greenbelt, MD 20771.*

Wet "Water Year"

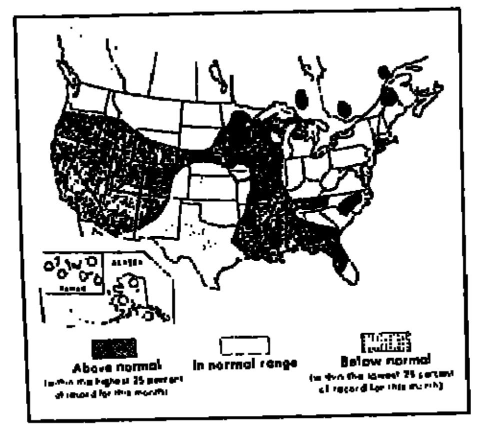
The nation's streams for the 1983 water year (October 1, 1982, to September 30, 1983) were much wetter than average, considering the dry conditions that prevailed over much of the East and the Midwest at the end of the water year, according to the U.S. Geological Survey (USGS).

USGS hydrologists said that for 174 key index gaging stations across the country, 48% had flows that were well above average (within the highest 25% of record) for the water year and only 6% (11 stations) reported well below average flows (within the lowest 25% of record).

Above-average flows for the water year stretched from Oregon and California into the Rocky Mountain region and as far east as parts of Nebraska. The wet conditions also blanketed much of the area drained by the Mississippi River, from Minnesota to Louisiana. Streamflow for much of the Gulf Coast region and east into Georgia and Florida was also above average for the water year, despite well below average flows throughout the Southeast in recent months (see map, courtesy of USGS).

The water-year concept is designed to roughly follow the growing season and to begin and end during a period of generally low streamflow.

"Despite the dramatic downturn for some streams in the East and the Midwest in recent months, the overall picture for the nation was above average for the water year," said Carroll Saboe, USGS hydrologist and chief of the hydrologic information unit, Reston, Va. "For some streams, the unusually wet winter and the excessive runoff from the spring rains and snowmelt boosted flows and groundwater levels to such high levels that there was sufficient carryover to supplement streamflow into the drier months that followed. Had there not been that extra cushion of runoff, we could have seen a much more widespread drought than what we actually experienced."



As a further indication of the generally healthy state of the nation's water resources for the 1983 water year, the combined flow of the three largest rivers in the coterminous United States—the Mississippi, St. Lawrence, and Columbia—was 3737 billion liters per day (822 billion gallons a day), 26% above average for the water year.

Water Resources Research Editor

The leading journal in the water sciences is seeking candidates and nominations to succeed Stephen J. Burges, whose term as editor ends December 1984.

To respond to the increasing number of high-quality submissions, *Water Resources Research* (WRR) will be published monthly beginning January 1984. The successful candidate will handle original contributions on the physical, chemical, and biological aspects of water research.

AGU President James A. Van Allen has appointed a committee to recommend candidates for the 1985–1988 term. Resumes of those interested in serving in this prestigious post, or letters of recommendation from those who wish to suggest candidates for it, should be sent by February 15, 1984, to WRR Editor Search Committee, American Geophysical Union, 2000 Florida Ave., N.W., Washington, DC 20009.

Carbon Dioxide and Climate

The earth's climate is getting warmer because of a buildup of carbon dioxide in the atmosphere that will continue well into the next century, according to a report released October 20 by the National Research Council (NRC), the research arm of the National Academy of Sciences. As the result of a 2-year study commissioned by Congress, the NRC's Carbon Dioxide Assessment Committee predicts a global temperature rise of as much as 4.5°C by the year 2100, enough to shift weather patterns, raise sea levels, and eliminate agriculture in some parts of the world. What's more, the trend seems inevitable—even drastic changes in our energy use would not prevent the warmup, according to the committee's findings.

CO_2, the major contributor to a thermal "greenhouse effect" that traps re-radiated heat in the atmosphere, has risen from a concentration of 315 parts per million (ppm) to 340 ppm in one generation, largely as a result of the use of fossil fuels. Sometime in the third quarter of the next century, the report predicts, the concentration will probably be double the current level. The result will be a global warming of surface air of between 1.5° and 4.5°C, with temperature rises relatively greater at the poles.

The committee predicts "with considerable confidence" this overall increase in the mean global temperature, then goes on to extrapolate more specific effects. Sea level, for example, will rise sharply compared to the 15 cm it has risen during the past century. "If a global warming of about 3 or 4°C were to occur over the next hundred years, it is likely that there would be a global sea-level rise of about 70 cm," the report states, because of melting glacial ice and the expansion of upper ocean waters as they heat up. If the west Antarctic ice sheet should begin to break up, the rise in sea level could be even greater.

The committee also foresees that summer soil moisture will decrease in the middle and high latitudes of the northern hemisphere and that a warming of even 2°C will severely reduce the quantity and quality of water resources in the western United States by affecting rainfall and river discharge. Despite the warmer, drier climate, the committee believes that these negative impacts on agriculture will be offset, at least "over the next couple of decades," because plants will be more efficient in using water and producing food in a CO_2-rich environment. The more severe

News (cont. on p. 931)

Forum

Geophysical and Geochemical Consequences of Nuclear Explosions

An all-Union session on the geophysical and geochemical consequences of nuclear explosions was commissioned by the AGU Public Affairs Committee and will be given at San Francisco Wednesday morning, December 7, 1983. The session is deliberately restricted to aspects within the domain of the American Geophysical Union, and the social, political, and ethical issues will not be treated explicitly. It is inevitable that such issues will be present in the minds of the speakers and audience, but they cannot be evaluated by rigorous scientific methods. The aim of the session is to examine the possible range of geophysical and geochemical consequences of various scenarios involving nuclear explosions. Such scenarios extend from a single nuclear explosion to a major nuclear exchange involving thousands of weapons. A Wednesday afternoon session at the Fall Meeting will examine atmospheric consequences.

Moral Obligations

We geophysicists and geochemists have a moral obligation to scrutinize all pertinent data and speculations as thoroughly as possible, and present the conclusions without bias and prejudice. I must confess to a fear and hatred of the subject; I am forced to screw up my courage to read the literature. As justification for our involvement in this session, consider this quotation from "The Effects of Nuclear War" [*Office of Technology Assessment*, 1980]:

"At the request of the Senate Committee on Foreign Relations, the Office of Technology Assessment has undertaken to describe the effects of a nuclear war on the civilian populations, economies, and societies of the United States and the Soviet Union.

"Nuclear war is not a comfortable subject. Throughout all the variations, possibilities, and uncertainties that this study describes, one theme is constant—a nuclear war would be a catastrophe. A militarily plausible nuclear attack, even 'limited,' could be expected to kill people and to inflict economic damage on a scale unprecedented in American experience: a large-scale nuclear exchange would be a calamity unprecedented in human history. The mind recoils from the effort to foresee the details of such a calamity, and from the careful explanation of the unavoidable uncertainties as to whether people would die from blast damage, from fallout radiation, or from starvation during the following winter. But the fact remains that nuclear war is possible, and the possibility of nuclear war has formed part of the foundation of international politics, and of U.S. policy, ever since nuclear weapons were used in 1945.

"The premise of this study is that those who deal with the large issues of world politics should understand what is known, and perhaps more importantly what is not known, about the likely consequences if efforts to deter and avoid nuclear war should fail. Those who deal with policy issues regarding nuclear weapons should know what such weapons can do, and the extent of the uncertainties about what such weapons might do."

The journal *Ambio* presented a special issue on Nuclear War: The Aftermath [*Ambio*, 1982]. The introduction contains this statement: "... the impact of a nuclear war would be far more devastating to the biosphere than any other threat that is likely to appear in our time. And the likelihood of such a war occurring does not seem to be diminishing." I believe that this statement justifies our moral obligation as members of the human race to present our scientific conclusions at broad-based meetings in which the ethical, social, and political issues are also considered. However, these combined issues are so complex and controversial that they should be sponsored by organizations other than AGU.

The history of arms-control talks [e.g., *York*, 1983] teaches us that scientific data and conclusions provide a fundamental basis for the agenda and technical agreements. The session at the 1983 AGU Spring Meeting in Baltimore on detection and evaluation of underground nuclear explosions is an important example of the value of an open forum. Let us hope that the AGU session at San Francisco will lead to general acceptance of a body of scientific facts and reasoned speculations on the serious geophysical and geochemical consequences of nuclear war, and that political and diplomatic leaders will be able to use this information to negotiate agreements for safeguarding the human race.

Key Literature

An extensive scientific literature on the effects of single nuclear explosions includes *Glasstone and Dolan* [1977]. This is an authoritative review based on observations in 1945 of the two small nuclear explosions (10–20 kilotons) above Hiroshima and Nagasaki, and on many test explosions up to 50 megatons above and below land and sea surfaces mainly in good weather. Although the engineering of nuclear weapons is complex, the scientific principles of fission and fission-fusion-(fission) weapons are well known. If the type of weapon and position of detonation are specified, the physical and chemical consequences in the first few seconds and minutes can be estimated fairly accurately. Thereafter, the consequences depend considerably on the meteorological conditions; in particular, the wind drift of a debris cloud, and especially the possibility of rain-induced fallout, must be considered. As the height of the detonation increases, there is less disturbance near the ground and an increasing degree of ionization in the atmosphere. Large amounts of nitrogen oxides and other gases are produced, and a high-altitude explosion will reduce the ozone concentration in the stratosphere. Dust in the upper troposphere and stratosphere can remain suspended for months or years, and the recent data on volcanic ejecta from Mount St. Helens and El Chichón are relevant in regard to the geographic extent and rate of dispersal over the entire earth. A tutorial on the effects of nuclear explosions over Detroit and Leningrad is given in an Arms Control and Disarmament Agency report on The Effects of Nuclear War; and *Office of Technology Assessment* [1980] examines effects of an explosion over Washington, D.C.

There are fortunately no observations on multiple nuclear explosions during a short period (several hours), but there are several published scenarios involving various numbers of weapons aimed at military and civilian targets. A report on the *Long-term Worldwide Effects of Multiple Nuclear Weapons Detonations* [*National Academy of Sciences*, 1975] has considered atmospheric effects (radioactive fallout, photochemical effects, temperature effects, climatic implications), natural terrestrial ecosystems, managed terrestrial ecosystems, the aquatic environment, somatic effects on humans, and genetic effects on humans. Chapter 1, by J. P. Friend and others made a thorough evaluation of the atmospheric effects expected for a nuclear exchange of 10^4 megatons in the northern hemisphere. Simple scaling, to the effects of the above-ground nuclear explosions that were conducted before the test ban, produced an estimate of average cumulative fallout of 1 Curie/km² of ^{90}Sr in the northern hemisphere; hot-spots, not in the immediate vicinity of nuclear-explosions, would be 2 to 5 times more intense. The production of 10^{34} molecules of NO would be 5–50 times greater than the natural amount in the stratosphere, and might cause a 2-fold reduction in the amount of ozone. About 10^7–10^8 tons of dust might be injected into the stratosphere, and simple comparison with the Krakatau eruption would suggest a temperature decrease of about half a degree Celsius over the mean surface of the earth. All these conclusions were tentative, and further study was recommended: in particular, all models were too simple, and synergism might be important.

Inclusion of the effects of smoke and toxic gases from huge fires indicates severe consequences. The summary in *Crutzen and Birks* [1982] states:

"As a result of nuclear war vast areas of forest will go up in smoke—corresponding at least to the combined land mass of Denmark, Norway, and Sweden. In addition to the tremendous fires that will burn for weeks in cities and industrial centers, fires will also rage across croplands and it is likely that at least 1.5 billion tons of stored fossil fuels (mostly oil and gas) will be destroyed. The fires will produce a thick smoke layer that will drastically reduce the amount of sunlight reaching the earth's surface. The darkness would persist for many weeks, rendering any agricultural activity in the Northern Hemisphere virtually impossible if the war takes place during the growing season."

This conclusion is based on a nuclear exchange of 14,700 weapons totalling 5700 megatons. Most of the weapons would be smaller than 1 megaton and most of the nitrogen oxides would be deposited in the troposphere. The soot from the fires would amount to a lower mass than the airborne debris from Krakatau or Mount St. Helens, but the black carbon would absorb light much more strongly than volcanic glass. Hydrocarbons would combine with other gases to produce a photochemical smog. All the proposed effects are difficult to quantify because of uncertainty in the starting parameters (e.g., a thick snow cover would reduce fire risk, and would be vaporized to produce a wet atmosphere; a turbulent atmosphere would promote early fallout); in the dynamical and chemical processes of the atmospheres; and in the accuracy of computer models.

All-Union Session at San Francisco

Several scientific groups are tackling these complex atmospheric problems, and it was decided to concentrate on their work in the all-Union session at San Francisco. The morning session, in the International Room of the Cathedral Hill Hotel, is deliberately designed for the entire membership of AGU and invited guests from the public information services. All speakers will concentrate on the major processes and conclusions without resort to unnecessary jargon and detail. An afternoon session in the Crystal Room of the Holiday Inn will concentrate on the details of the atmospheric processes.

I will present an introduction and overview at the outset of the morning session. To produce a reference point, the second paper by T. J. Ahrens and J. A. O'Keefe reviews the evidence on huge impacts on the earth throughout geologic time, with emphasis on the Cretaceous-Tertiary global extinction. J. S. Chang lists possible global effects of a nuclear war and discusses the assumptions and uncertainties in models which predict a 50% destruction of the protective ozone layer. J. W. Birks and J. Staehelin evaluate the air quality following a nuclear war, with emphasis on the components (nitrogen oxides, carbon monoxide, hydrocarbons) for a photochemical smog. Interaction with smoke is discussed, and a detailed simulation is given for a one megaton airburst over Denver. J. B. Knox presents a synopsis of the studies at Lawrence Livermore National Laboratory on radiation fallout, ozone depletion, and smoke-dust-gas mixtures. The importance of the moisture and temperature profile for self-induced rainout of radioactivity is discussed. Synergism requires further study.

R. P. Turco reviews the sources of atmospheric dust and smoke in a nuclear exchange, and uses evidence from manmade and natural phenomena. He concludes that fires from major urban centers alone could cause major atmospheric disturbances. In a follow-up paper, O. B. Toon, T. P. Ackerman, and J. B. Pollack present calculations on severe loss of sunlight from a large and even a small nuclear exchange with consequences intermediate between those for large volcanic eruptions and the Cretaceous-Tertiary event. Substantial alteration of the dynamical processes in the atmosphere should occur. S. H. Schneider gives a summary of the application of general circulation models by a group at the National Center for Atmospheric Research. Intense heating of the mid-atmosphere would occur from absorption of solar radiation by soot, frost patches might occur at any season and latitude, and changes of circulation patterns might increase the southward transport of radioactive debris. P. W. Crutzen concludes the morning session with an overview which will emphasize the interrelationships between the various processes.

The titles of the papers to be presented at the afternoon session are as follows (see *Eos*, November 8, 1983, for full meeting details): Stratospheric Ozone Reduction at Early Times on Subcontinental Scale; Chemical Response of the Troposphere to Smoke, Dust, Smog and Ozone Depletion; Climatic Effects of Spreading Smoke and Dust; Generation, Physical Properties, Atmospheric Dispersion, and Effects of Smoke Following a Nuclear War; The Role of Short and Longwave Radiative Forcing in the Climatic Effects Due to Nuclear War; and Influence of Physical Processes in General Circulation Model Simulations of Massive Atmospheric Soot Injections.

Further AGU Activity

The Public Affairs Committee of AGU will continue its activity via a subcommittee on Geophysical Aspects of Nuclear War and Arms Limitation chaired by Jared L. Cohon (*Eos*, October 11, 1983, p. 588). Future all-Union sessions may be desirable to cover (1) the fate of radionuclides in the water and solid materials at the earth's surface; (2) the nature of the electromagnetic pulse and its relation to ionization processes in the atmosphere; and (3) new simulations of the atmospheric processes discussed at San Francisco. The 1984 AGU Spring Meeting at Cincinnati might be suitable, and potential contributors are invited to write to me as soon as possible (or phone 312-962-8110, Thursday or Friday morning preferred).

Other Activity

Several groups are working on the consequences of nuclear explosions. A group headed by G. W. Carrier (Harvard) is expected to submit a report shortly to the National Academy of Sciences, and an International Seminar on Nuclear War was held at Erice, Italy, this summer. I should be grateful for information on other activities.

Acknowledgments

Thank you to Carroll Ann Hodges, chairman of the AGU Public Affairs Committee, for asking Tom Ahrens and me to organize the all-Union session at San Francisco. And many thanks indeed to all the speakers for giving so much time and psychological energy to their presentations. I am particularly indebted to Paul W. Crutzen, Joseph Knox, Michael McCracken, Stephen Schneider, and Richard Turco for so much detailed advice about speakers and topics.

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Cover. ISEE-3 orbit in the earth's distant magnetotail during 1983. A new technique was used to achieve two lunar swing-bys to increase the satellite's observation time in the distant tail. See news article this issue. (Figure courtesy of Tycho von Rosenvinge, NASA Goddard Space Flight Center.)

News *(cont. from p. 929)*

effects will be felt by farmers who import water through irrigation, although even here the report suggests that long-term impacts may be countered by new developments in agricultural technology.

Despite their confidence in the global warming trend, the NRC committee report is sprinkled with caveats. If, for example, deforestation is a bigger factor in the buildup of CO_2 in the atmosphere than is now believed (making fuel use a relatively smaller factor), the authors warn that their model would be "seriously flawed," and the predicted rise in CO_2 levels probably would occur more slowly. On the other hand, if atmospheric increases for other "greenhouse gases" such as nitrous oxide and chlorofluorocarbons are factored in, then the buildup may be faster. And, given the uncertainties of future fuel consumption patterns and politics, the committee has "much less confidence" in their prediction of regional climatic changes or the social and economic implications of those changes.

The NRC study was ordered by the Energy Security Act of 1980, which called upon the White House Office of Science and Technology Policy to request the National Academy of Sciences to assess the global CO_2 problem so that Congress might make a more informed decision on synthetic fuel development. The committee favors continued study of atmospheric CO_2 and the greenhouse effect but no immediate changes in policy. "There is reason for caution, not panic," in the words of chairman William A. Nierenberg of the Scripps Institution of Oceanography. The report concludes that no near-term plans for reducing consumption of fossil fuels would either be justified or effective in solving the problem. "Viewed in terms of energy, global pollution, and worldwide environmental damage, the 'CO_2' problem appears intractable," the report states. "Viewed as a problem of changes in local environmental factors ... the myriad of individual incremental problems take their place among the other stresses to which nations and individuals adapt."

The NRC report, entitled "Changing Climate," followed by two days an Environmental Protection Agency (EPA) report that reached the same conclusions as to the inevitability of a CO_2-related global warming trend, but differed slightly on the timetable. In the EPA prediction, the climate would noticeably warm up sooner than in the NRC scenario, with major changes in the 1990's. Mean temperatures would rise 2°C by the year 2040, and 5° by the year 2100.—*TR*

DOE Geosciences Research

The Department of Energy (DOE) supports research in the geosciences at 25 university campuses as well as at the national laboratories and the National Academy of Sciences (NAS). Funds for the program have grown sharply since 1969, when the total for university research amounted to $483,000. The last 3 years have seen major funding increases. The total was $3.026 million in 1981, $3.141 million in 1982, and $4.519 million in 1983. Grants to individual investigators ranged from a low of about $40,000 to a high of about $337,013 in fiscal year 1983, and the average grant for that year was about $130,000.

Most of the university projects have to do with geothermal systems: mechanical properties of rocks, magmas, and transport of fluids in rock systems. A few studies are related to thermochemical properties of synthetic silicate materials. The projects seem to be focused on the general problems associated with geothermal sources and with radioactive waste storage, but the studies range from upper atmosphere measurements to organic geochemistry and to structural geology.

The Geosciences Research Program at DOE supports studies by the Committee on Seismology, the U.S. National Committee for Geochemistry, the U.S. Geodynamics Committee, Continental Scientific Drilling Committee, and Geological Sciences Board of the NAS National Research Council. These groups set up national initiatives and report on national geological needs.

The research categories supported include geology, geophysics, and earth dynamics; geochemistry; energy resource recognition, evaluation, and development; hydrologic and marine sciences; and solar-terrestrial-atmospheric interactions.—*PMB*

GRL Plans Issue on Arctic Haze

Arctic haze, a winter-spring air pollution phenomenon in the Arctic, has recently become the focus of accelerating research interest. In the spring of 1983 alone, at least seven atmospheric research aircraft from four nations were involved in studies related to Arctic haze. Extensive ground measurements of haze parameters were conducted by five countries with interests in the Arctic.

These and earlier programs have produced new and exciting information covering a diverse range of topics. To assist in the overall study, interpretation, and dissemination of these data in a timely manner, a special issue/section of *Geophysical Research Letters* will be dedicated to the subject of Arctic haze and related meteorological/atmospheric studies. Publication is planned for the spring of 1984.

The deadline for submission of papers is December 31, 1983. All papers will be subject to the normal GRL size limits, page charges, and review criteria as set forth in any recent issue. Guest editor for this special issue is:

Dr. Russell C. Schnell
NOAA/GMCC
R/E/AR4
Boulder, CO 80303

FTS 320-6661
303-497-6661
Telex: 45897 SOLTERWARN

Please notify the guest editor now if you plan to submit a paper to this special issue. Before the end of 1983 send four copies of your manuscript to the guest editor; one copy to the GRL Editorial Office, 2455 Hayward, Ann Arbor, MI 48109; and one copy to AGU, 2000 Florida Ave., N.W., Washington, DC 20009.

JGR Papers on LAGEOS

AGU is inviting contributions to a special issue of the *Journal of Geophysical Research* (JGR) devoted to the results from analyses of Laser Geodynamics Satellite (LAGEOS). Examples of topics appropriate for the issue include, but are not limited to:

(1) Geodesy: gravity field, intersite baseline distances, polar motion, earth tides, and satellite orbit perturbations

(2) Tectonophysics: tectonic plate motion, crustal deformation, gravity and geoid interpretation, and mantle convection, structure, and rheology

(3) Solid earth-ocean-atmosphere interactions.

All analyses should be based on LAGEOS data or make extensive use of LAGEOS data along with other information. Peer review of all papers will be in accord with the usual JGR standards. Papers, in the standard AGU manuscript format, should be received by editors no later than February 29, 1984.

Send one copy to:

Steven Cohen
Guest Editor, LAGEOS Special Issue
Geodynamics Branch, Code 921
Goddard Space Flight Center
Greenbelt, MD 20771

Send four copies to:

Gerald Schubert
Editor, *Journal of Geophysical Research*
Department of Earth and Space Sciences
University of California, Los Angeles
Los Angeles, CA 90024

Authors should advise Cohen by December 31, 1983, of their intention to make a contribution. He can be reached at the above address or by telephone at 301-344-8826.

Geophysical Events

This is a summary of *SEAN Bulletin*, *8*(9), September 30, 1983, a publication of the Smithsonian Institution's Scientific Event Alert Network. The entire Miyakejima and Rabaul reports are shown; the earthquake report is an excerpt. The complete bulletin is available in the microfiche edition of *Eos* as a microfiche supplement or as a paper reprint. For the microfiche, order document E83–009 at $2.50 (U.S.) from AGU Fulfillment, 2000 Florida Avenue, N.W., Washington, DC 20009. For the paper reprint, order *SEAN Bulletin* (giving volume and issue numbers and issue date) through AGU Separates at the above address; the price is $3.50 for one copy of each issue number for those who do not have a deposit account, $2 for those who do; additional copies of each issue number are $1. Subscriptions to *SEAN Bulletin* are available from AGU Fulfillment at the above address; the price is $18 for 12 monthly issues mailed to a U.S. address, $28 if mailed elsewhere, and must be prepaid.

Volcanic Events

Kilauea (Hawaii): 8th–10th major phases of E Rift Zone eruption; lava fountains to 300 m feed flows to NE and SE

Mt. St. Helens (Washington): Lava from new vent added to composite dome

Veniaminof (Alaska): Eruption resumes; strombolian activity; lava flows

Pacaya (Guatemala): Strombolian bursts and lava flows in summit crater

Una Una (Indonesia): Satellite observations of July-August eruption clouds

Miyakejima (Japan): Tephra cloud to 10 km; lava flows

Rabaul (New Britain): Earthquake swarms and uplift at intracaldera cone

Langila (New Britain): Explosions, tremor from gas venting; glow seen twice

Manam (Bismarck Sea): 4 days of stronger activity, ashfalls to 10 km

Papua New Guinea: Gas measurements at 4 volcanos

Pagan (Mariana Is.): Small plume emitted

Atmospheric Effects: El Chichón cloud remains over mid-latitudes

Miyakejima Volcano, Izu Islands, Japan (34.08°N, 139.53°E). All times are local (= GMT + 9 hours).

Miyakejima erupted on October 3 after 21 years of quiescence. Two hours of increasing seismicity preceded the eruption onset. A column of tephra and vapor rose to 10 km, and lava flowed down the SW flank.

Small earthquakes began to be recorded at the Japan Meteorological Agency (JMA) Miyakejima Weather Station at 1358. Weak shocks were felt at the same time in Ako, the largest village on the SW coast. Seismicity increased gradually, and from around 1430 to 1523 as many as 2–3 earthquakes per minute were recorded. The first felt shock (JMA intensity 1) at the weather station occurred at 1448, followed by others at 1500 (JMA 2), 1514 (JMA 1), and 2 at 1522 (both JMA 2). Many more shocks were felt in Ako.

JMA personnel judged that the eruption began at 1523, when the amplitude of recorded continuous tremor began to increase. Tremor saturated the seismograph by 1527 and high amplitudes persisted for hours.

The eruption began in the summit crater (Oyama), and downslope along a 3 3-km-long fissure from the summit to the SW coast. Lava fountains rose to a few hundred meters from more than nine vents. The lava advanced in five flows, 300–400 m wide, starting forest fires in many places. The largest flow reached Ako, and a smaller one reached Usuki village about 1800; 90% of Ako was destroyed but there were no casualties. Lava reached the sea about 1900.

The pilot of a Japanese airliner reported that an eruption column had reached 10-km altitude around 1600. Tephra covered the entire, 55-km² island. Tephra was thickest on the E half of the island, where 20–30 cm of ash and lapilli accumulated; many car windshields were broken. In the SW sector, 7–8 cm were reported. The airport was closed by the clouds of tephra and about 7.5 cm of ash and fist-sized tephra on the runway. Rescue planes en route to the island had to return to Tokyo Airport.

Spectacular fountaining and frequent loud explosions continued until midnight. An underwater explosion at the SW end of the fissure was observed from a fishing boat about 2330. Activity subsided during the night and only voluminous white smoke was observed on October 4. There were press reports of a new island off the S coast but these were not confirmed by scientific sources.

Between the onset of the eruption and 0100 on October 4, 59 felt earthquakes were recorded. Earthquake activity, which had declined at the onset of the eruption, resumed at 1812 and increased gradually. At 2233 a magnitude 5.7 (M_s) shock struck the island. Preliminary USGS data placed the event at 34.06°N, 139.45°E, at shallow depth. The shock caused landslides at about 10 places along island roads, and was felt weakly in Tokyo and throughout the Kanto district on Honshu, 180 km to the N. After this earthquake, seismic activity decreased through October 4.

Three felt earthquakes and a series of weak events of different character from those that preceded the eruption occurred between 1700 and 2100 on October 5. About 3000 earthquakes including 109 felt shocks had been recorded on Miyakejima from late 1982 through January 1983.

When the eruption began, island residents fled to schools and other buildings designated as shelters, but 30 were forced from the Tsubota town hall (3.5 km SE of the summit) when the roof began to collapse under the weight of tephra. About 2000 residents were moved from the endangered area near the eruption zone to the N coast. There were no casualties. Eleven government ships arrived to stand by in case the entire island population of 4400 needed evacuation. About 10% of the population left the island on October 4.

Although heavy rain on October 5 cooled the lava, a stream that threatened the 60 remaining buildings in Ako continued to advance about 1/3 m per hour. On October 6 firemen tried to halt it by spraying water on its front.

Miyakejima's most recent eruption was August 24–27, 1962, when explosions and lava flows originated from fissures running down the NE flank. In the 13 recorded eruptions since the year 1085, Ako was destroyed or badly damaged in 1643, 1712, 1763, and 1835.

Information Contacts: Office of Volcanic Observation, Seismological Division, Japan Meteorological Agency, 1-3-4 Ote-machi, Chiyoda-ku, Tokyo 100, Japan; Tokiko Tiba, National Science Museum, Department of Geology, 3-23-1 Hyakunin-cho, Shinjuku-ku, Tokyo 160, Japan; The Japan Times, Tokyo, Japan; Kyodo News Service, Tokyo, Japan; Agence France-Presse; Deutsche Presse-Agentur; Associated Press; United Press International.

Rabaul Caldera, New Britain Island, Papua New Guinea (4.271°S, 152.203°E). The following is a report from Peter Lowenstein.

"An exponential increase in seismic activity in Rabaul Caldera began in late August and culminated in an intense crisis with 621 earthquakes on September 19. The strongest event had a magnitude of ML 4.2. Since then seismicity has remained high at 40–120 events per day and has included several minor crises. The total number of caldera earthquakes in September was 2135, which is a sig-

News *(cont. on p. 932)*

News *(cont. from p.931)*

nificant increase over the previous highest monthly totals of 1170 and 1079 in January and March 1982.

"The earthquakes have been concentrated at depths of 0–3 km near Tavurvur Volcano, a small post-caldera cone on the E section of the elliptical caldera bounding fault, but other sections of this fault have also been seismically active.

"Tilt measurements showed distinct uplift centered 1.5 km S of Tavurvur. Uplift commenced in early September in relation to increasing seismicity. A sharp tilt change of up to 49 microradians accompanied the seismic crisis of September 19, but tilt rates have since returned to normal. The depth and increase in volume of the source of ground deformation are estimated to be about 1.7 km and 1.9 million cubic meters."

Information Contact: P. Lowenstein, Senior Government Volcanologist, Rabaul Volcano Observatory, P. O. Box 386, Rabaul, Papua New Guinea.

Earthquakes

Date	Time (UT)	Magnitude	Latitude	Longitude	Depth of Focus	Region
September 7	1922	$6.3M_s$	60.99°N	147.39°W	shallow	S Alaska, USA

Information Contact: National Earthquake Information Service, USGS, Stop 967, Denver Federal Center, Box 25046, Denver, CO 80225 USA.

Meteoritic Events

Fireballs: Brazil; Georgia, Massachusetts, mid-Atlantic, North Dakota, Oklahoma, Oregon (4), USA.

Geophysicists

Roger J. M. De Wiest has been appointed distinguished professor and director of hydrology of the newly established hydrology program at Tarleton State University, a part of the Texas A&M University system. He is one of four full-time water scientists and engineers in the new program.

The newsletter of AGU's Committee on the History of Geophysics reports that **Sylvia Fries**, a research associate professor of history at the University of Maine, has been appointed to serve as director of the National Aeronautics and Space Administration history office. The position has been vacant since November 1982, following the retirement of **Monte Wright**.

Mohammed Asad Khan, a University of Hawaii professor of geophysics, recently was appointed Pakistan Minister of State for petroleum and natural resources.

Walter Sullivan, science editor of *The New York Times*, received the Association of Earth Science Editors' Award for Outstanding Editorial or Publishing Contributions. The award was presented at the association's meeting in mid October. Sullivan has been a member of AGU since 1957.

Sandra Toye, executive officer for the National Science Foundation's (NSF) Office of Scientific Ocean Drilling (OSOD) for 2 years, is the new program director for NSF's Ocean Drilling Program (ODP). OSOD was transferred to NSF's Division of Ocean Sciences earlier this year (*Eos*, July 5, 1983, p. 443); the Advanced Ocean Drilling Program (AODP) has been renamed ODP. Other staff in ODP are **Alexander L. Sutherland**, associate program director; **Herman B. Zimmerman**, program associate for science coordination; and **Jennieve D. Gillooly**, program assistant. **Anton L. Inderbitzen**, former OSOD program manager for science, has transferred to the science section in NSF's Division of Polar Programs.

In Memoriam

Earl W. Barrett, 64, died on August 3. A member of the Atmospheric Sciences section, he joined AGU in 1948.

Joseph W. Howe, 81, died on October 19, 1983. The professor emeritus of hydraulic engineering at the University of Iowa had joined AGU in 1938. A member of the Hydrology section, he was a Life Member.

Vladimer Sobolev, 75, died. A member of the Volcanology, Geochemistry, and Petrology section, he joined AGU in 1972.

Books

Gravity

C. Tsuboi, George Allen and Unwin, Boston, xiv + 254 pp., 1983, cloth $40, paper $19.95.

Reviewed by L. E. Wilcox

According to its preface, *Gravity* is intended to provide a fundamental knowledge about gravity and the use of gravity data for understanding the geophysical structure of the earth. The material included is based upon lectures given at the University of Tokyo by the author with added results obtained after his retirement from the university. The book was originally published in Japanese in 1979 and was translated into English by the author for the current edition.

C. Tsuboi was Emeritus Professor of Physics at the University of Tokyo until his death early in 1983. Throughout his career, he was an active worker in the areas of gravity measurement and interpretation. His contributions will be missed.

The coverage of the subject of gravity presented by this book is reasonably comprehensive. Most of the fundamental concepts of gravity are treated—some quite briefly, some in more detail. The book is clearly intended for an undergraduate geophysical audience, but geodesy students might benefit by reading some of the elementary yet interesting approaches taken by the author.

The selection of topics discussed in this book is a little different than I have seen in similar books, and it may be useful to summarize its major contents.

The book begins with a brief but exceptionally clear introductory chapter that describes the elemental concepts of gravity, gravitation, centrifugal force, the geoid, and the Eotvos effect. Toward the end of the chapter, the purposes of gravity measurement are stated to be (1) determining the shape of the earth, (2) finding the underground mass distribution, (3) estimating the elasticity of the earth, (4) seeing if gravity values change with time, and (5) standardizing physical and chemical constants. All but the last of these topics are discussed later in the text, but most attention is given to the second purpose.

The chapter on gravity measurement emphasizes the pendulum methods (absolute, relative, submarine), with separate sections on ballistic absolute gravity measurements, gravimeter measurements, and surface ship measurements.

The free-air and Bouguer reductions and terrain correction are treated in a clear and elementary manner in the chapter on gravity reduction. The approach here is decidedly geophysical in outlook and methodology.

The computation of flattening (here called ellipticity) from gravity is developed with reference to the calculations of Newton, Huygens, and Clairaut. Methods for computing the gravitational effects of underground masses are discussed for a number of simple geometric shapes and figures.

The potential of gravity is briefly introduced and Laplace's equation is set up in cartesian, cylindrical, and spherical coordinates. This equation is solved for the cartesian and cylindrical cases only. Methods to compute geoid heights and deflections of the vertical are presented for each of the three coordinate systems. Fully one third of the book is devoted to the solution of Laplace's equation and various topics on interpretation of earth structure using related methods.

Another chapter covers second derivatives of the gravity potential, the torsion balance, and their applications. A good introduction to tidal variations in gravity follows. A short discussion of nontidal gravity changes is included here.

The book concludes with a clear discussion of isostasy and its implications to gravity and earth structure, a chapter on the behavior of gravity at sea with simple structural interpretation examples, and a chapter on interpretations of gravity in areas characterized by volcanos and earthquakes.

Throughout the text, its origin in lecture notes for the University of Tokyo is clearly apparent. For example, many of the specific examples given pertain to Japan and its surrounding waters. In addition, the selection of material presented and depth of coverage of various topics suggest a course designed to be a survey of the geophysical aspects of gravity. Still, the material is very coherent and flows nicely.

Historical methods and procedures may be emphasized too much at the expense of more modern techniques. For example, considerable space is given to pendulum and torsion balance measurement, while falling body methods and gravimeters receive relatively brief coverage. The satellite methods of gravity determination are mentioned only in passing.

The coverage of gravity-related topics is fundamental and basically elementary. Most of the material presented is clear and concise and should be comprehended by a nonspecialist. I found the book fun to read and to contain a number of interesting approaches and topics that I have not seen in print elsewhere. I feel it is an interesting reference source for those experienced in gravity applications, and an excellent and reasonably comprehensive introduction to the geophysical aspects of gravity for those who are new to this field.

L. E. Wilcox is with the Defense Mapping Agency Aerospace Center, St. Louis, MO 63118.

Igneous Rocks

Daniel S. Barker, Prentice-Hall, Englewood Cliffs, N.J., 417 pp., 1983.

Reviewed by Bruce R. Doe

"*Igneous Rocks* was written for undergraduate geology majors who have had a year of college-level chemistry and a course in mineralogy . . . and for beginning graduate students. Geologists working in industry, government, or academia should find this text useful as a guide to the technical literature up to 1981 and as an overview of topics with which they have not worked but which may have unanticipated pertinence to their own projects." So starts the preface to this textbook.

As one who works part time in research on igneous rocks, especially as they relate to mineral deposits, I have been looking for such a book with this avowed purpose in a field that has a choking richness of evolving terminology and a bewildering volume of interdisciplinary literature. In addition to the standard topics of igneous petrology, the book contains a chapter on the role of igneous activity in the genesis of mineral deposits, its value to geothermal energy, and the potential of igneous rocks as an environment for nuclear waste disposal. These topics are presented rather apologetically in the preface, but the author is to be applauded for including this chapter. The apology shows just how new these interests are to petrology. Recognition is finally coming that, for example, mineral deposits are not "sports of nature," a view held even by many economic geologists as recently as the early 1960's; instead they are perfectly ordinary geochemical features formed by perfectly ordinary geologic processes. In fact, the mineral deposits and their attendant alteration zones probably have as much to tell us about igneous rocks as the igneous rocks have to tell us about mineral deposits.

The author also might well have had a chapter on the role of igneous petrology in geologic hazards concerns. The explosion of Mount St. Helens (briefly mentioned in the text) to some extent has broken our feeling that, in the conterminous United States, it can't happen to us. The Chichón explosion in Mexico (that erupted after this book went to press) has reminded us again that it can happen to us and even underlines a need for the ability to predict which eruptions will be sulfur rich (like Chichón) and which will not (like Mount St. Helens) because of climate modification aspects of sulfuric acid in the stratisphere.

Elsewhere in the last few hundred years, individual volcanic eruptions have resulted in tens of thousands of deaths as a result of ashfall burial, tidal waves, and, especially, crop failures in Italy, Iceland, and particularly Indonesia. Volcanic activity also produces high seismicity—the island of Hawaii is the most tectonically active area in the United States. The author, also, too easily dismisses the important role that volcanism plays in climate modification and the onset of glacial ages, in view of the recent Geological Society of America Special Paper on the topic [*Axelrod*, 1981]. Perhaps a future edition of *Igneous Rocks* will include a chapter on these volcanic hazards because they are not just a topic for engineering geologists.

There is a vast amount of material in the 417-page book that is helpful. There are discussions of komatiites, photomicrographs of textures to accompany textural explanations, and details on calculating various factors (such as CIPW norms, Thorton-Tuttle differentiation index, Peacock alkali-lime index, and many more of these involved schemes that are bandied about so freely in igneous petrology but which are so hard for the part-time researcher to remember).

One illustration of the difficulty of working in igneous petrology regards rock classification. After taking us through the labyrinth of the highly involved *IUGS*[1973] report on "Plutonic rocks, classification and nomenclature" and the just-as-involved classification of *Streckeisen* [1978], the author tells us (p. 98) that "the most widely accepted classification of volcanic rocks is that of *Irvine and Baragar* [1971]." However, their method "is too involved to be summarized here." Thus igneous-rock terminology is now in the state of being too complex to include in even a 417-page introductory text on the topic! Not only this, but the definitions of terms can change radically. As an illustration of this problem, when I did some research on the origin of shoshonites with my colleagues Zell Peterman and Hal Prostka in the 1960's, a shoshonite was a basalt containing olivine and pyroxene phenocrysts with K-feldspar in the groundmass. Now the author recommends the term be dismissed because (p. 281) "unusually potassium-rich latite should be called an unusually potassium-rich latite." *The author* repeatedly shows his awareness that igneous petrology is tripping over its own terms; in fact, one of his goals is to use this book to guide terminology usage in the future, a noble but probably futile endeavor. I offer the two examples above of the terminology problems to show why I felt the need of a book like *Igneous Rocks*.

The book contains a few words on just about all topics and terms used in igneous petrology. (Not all terms in popular use are discussed, however; for example, I looked in vain for *boninites*.) Such a comprehensive coverage is bound to be uneven, and sometimes misleading. For example, one could easily get the impression from the term *incompatible elements* that the geochemistry of lead follows that of the major elements magnesium, iron, and calcium, and that lead therefore would usually be *compatible* in the crystallization of malic igneous rocks; in fact it follows potassium and to some extent sodium, elements of less ionic charge but of more similar ionic radius. These elements tend to stay in the melt and therefore usually *incompatible* for mafic melts.

Another misleading use of terminology is *large ion elements*, which for some reason is substituted for *large ion lithophile elements* or *LIL elements*. No doubt this change is a part of the author's terminology-reform movement, but the students are going to be faced by *LIL elements* in the literature. Furthermore the author equates the terms *large ion* and *incompatible elements* and feels that the term *incompatible* is misleading (p. 82). The terms are not synonyms. An *incompatible element* is one that preferentially stays in a melt that has any particular assemblage of phases crystallizing. Thus an element may be *compatible* or *incompatible* depending on the phases crystallizing at the time. A *large ion lithophile element*, on the other hand, is one that stays in the melt when common phases of the mantle crystallize—olivine, pyroxenes, spinel, and garnet. The term *LIL element* is therefore more restrictive.

Isotopes are covered to some extent. Strontium isotopes are the workhorse in this text and are abruptly intruded into chapter 7 under the heading of magmatic assimilation (p. 137) and, later, of neodymium isotopes (p. 278). Oxygen isotopes are introduced on p. 234. Lead isotopes are mentioned only in passing. A better approach might well have been to have a short chapter near the beginning explaining how these isotopes work, with applications introduced later where appropriate.

The author states that igneous petrology is, by necessity, a descriptive science. Perhaps so, but I find the recent attempts to construct quantitative models to be healthy—as the author also states. In view of this, there is a surprising lack of equations in the text, although equations for equilibrium partitioning of trace elements in generalizing differentiation trends and (although it is not labeled as such) for Rayleigh distillation are given in a figure on p. 84. I had hoped to see more of these equations within the handy covers of one book, but they are not provided. Just why these equations are absent is not clear, as they are all "plug-in" equations easily handled by a modern, $15 pocket calculator possessing exponential key, logarithm key, etc. They are hardly beyond the grasp of present-day high school students, much less advanced undergraduates. Even the equations of the form of the radioactive-decay equation ($-dN/dt = \lambda N$) are absent, in spite of the discussion of radiogenic isotopes. Because equations of this form—radioactive decay, first-order reaction rates, absorption of X rays, etc.—are among the most commonly used in science, upperclassmen and beginning graduate students should be familiar with them. Unlike many textbooks, *Igneous Rocks* does not have problems or questions at the end of the chapters, a feature that is helpful in underlining the most salient points the author wishes to get across.

If the author too easily dismisses the possible role of volcanism in ice ages (p. 205), the suggestions (p. 147) that "it seems unlikely that the entire thickness of the crust can be pierced by a single pool of magma constantly changing composition and 'burning its way' upward" seems even more premature in view of the paper by *Ahern et al.* [1981] proposing just this. The controversy involving the origin of granitic and rhyolitic melts is not clearly presented anywhere; yet, the discussion of the variable roles of crustal anatexis by mafic melts versus fractional crystallization of mafic melts to form granites and rhyolites remains spirited after decades of study.

In spite of these and other shortcomings, a discussion of igneous rocks in any sort of comprehensive and organized fashion between two covers is a formidable job in the 1980's. It takes a courageous individual to make the attempt to do so. A review that focuses on the shortcomings of such a complex topic is all too easy to write. I did get—and, in fact, will continue to get for some time to come—most of what I wanted out of this book. If I felt that many important references have been omitted (among the 600 that are cited!), there are many important references that I had missed and am glad I now know about (e.g., the cited references on how much partial melting might be needed to permit droplets of magma to migrate and coalesce). In view of the increasing importance of igneous petrology to society and the author's recognition of this, many readers will find *Igneous Rocks* to be valuable.

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Bruce R. Doe is with the U.S. Geological Survey, Reston, VA 22092.

Circulation in the Coastal Ocean

G. T. Csanady, D. Reidel, Boston, x + 279 pp., 1982.

Reviewed by Y. Hsueh

Coastal ocean dynamics as a distinct branch of dynamic oceanography has seen a tremendous amount of growth in the past 20 years or so. Although there remain many areas of contention, a sufficient amount of common understanding now exists in the open literature that a synthesis is worthwhile and indeed welcome. *Circulation in the Coastal Ocean* represents an effort to accomplish just that. The emphasis is on motions in the coastal ocean that cause large net particle movements and is therefore particularly appropriate for the current concerns for the environment. The scope of the monograph is, however, much more limited than first expected. The reader is led through the development of theories and physical arguments essentially following the impressive list of literature contributions from the author. The gravitation toward the works of one man precludes discussions of other important topics and approaches.

The monograph is organized into two main sections, following an opening chapter that briefly summarizes some fundamentals. The first section is composed of four chapters (2–5) and deals exclusively with the inertial response of the coastal ocean forced by the suddenly imposed surface wind stresses. The discussion of the set-up process in chapter 2 is particularly elucidating and informative. The treatment in chapter 3 of the stratified ocean response in terms of individual vertical modes is elegant. The fact that solutions to the homogeneous problem can now be transcribed to give the behavior of a stratified coastal sea (albeit of a uniform depth) makes for an effective presentation.

The uniform-depth restriction is relaxed in chapter 4. The possibility of vorticity wave is introduced here in a way that is quite convincing. The discussion of coastal jet over a sloping beach is, however, not up to the standard of clarity of the early chapters. The chapter ends with a cursory look at coastal trapped waves in a stratified ocean with variable depth. The development of the theory is followed in chapter 5 by a discussion of observational results from two major experiments: the International Field Year on the Great Lakes, on Lake Ontario, and the Coastal Upwelling Experiment off the Oregon coast. Comparisons between theoretical understanding and observations are, however, largely qualitative. Results of statistical analysis which has contributed greatly to the explosive development of the field are sorely missed.

The second main section contains the rest of the monograph and is concentrated upon the equilibrium state of affairs in which the external forcing is balanced with dissipative processes, chiefly bottom friction. The discussion of the parameterization of bottom friction features a unique blend of empirical results and conceptual understandings. The outcome is a solid foundation for a formulation of the bottom stress that should prove useful in practice. The main attraction is, however, the analog of the spread of the sea level variation within a coastal boundary layer to the conduction of heat. It brings a large body of analytical tools to bear upon the coastal ocean circulation problem. The discussion in chapter 7 of the thermohaline circulation features the author's work on the geostrophic adjustment problem for a bottom-to-surface coastal ocean front and the advection and diffusion of freshwater. The final chapter presents observational evidence for the steady-state circulation depicted in theory, particularly, that in chapter 6, but again in a qualitative manner.

Other than the somewhat uneven quality in presentation that was alluded to earlier, the monograph also suffers from having numerous printing errors. These errors are quite a distraction to reading and hopefully will be eliminated in later editions.

Some readers will no doubt be disappointed with not finding here any discussion of numerical modeling results. While the author is correct in his assessment of the role of numerical modeling as mainly one of synthesizing analytical results, the value of numerical models in suggesting new directions for theoretical development and in providing a means for experimentation is unnecessarily downplayed.

On the whole, the monograph remains a valuable and timely contribution to coastal dynamics literature. The incorporation of a substantial amount of the work on the Great Lakes is particularly of value. These enclosed basins provide succinct examples of coastal dynamics, yet are often given less attention than they deserve.

As a text for graduate courses, the monograph could be broadened with discussions of mixing across fronts, tidal mixing, and perhaps further aspects of coastally trapped waves. For the professional, the book presents a banquet of physical insights and will prove to be a delightful addition to any shelf.

Y. Hsueh is with the Department of Oceanography, Florida State University, Tallahassee, FL 32306.

Correction

The review of *Physico-Chemical Behaviour of Atmospheric Pollutants* that appeared in *Eos*, August 2, 1983, p. 486, listed an incorrect price for the book. The correct price is $78.

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For further information, call toll free 800-424-2488 or, in the Washington, D. C., area, 462-6903.

POSITIONS AVAILABLE

Ohio State University/Paleobiologist. The Department of Geology and Mineralogy, The Ohio State University, invites applications for a tenure-track position for a paleobiologist with a strong quantitative background; research capabilities in a major group of invertebrate macrofossils; and the capacity to develop or expand a research program in biogeography, evolutionary paleobiology, functional morphology, or paleoecology that will augment existing programs in biostratigraphy, micropaleontology and sedimentary petrology.

Ph.D. or equivalent is required by the time of appointment. The successful applicant will be expected to teach graduate and undergraduate courses appropriate to their expertise, conduct research and supervise graduate students. Rank and salary commensurate with experience and research record. Please send applications or nominations as soon as possible to:

Dr. Walter C. Sweet
Chairman, Search Committee
Department of Geology and Mineralogy
The Ohio State University
Columbus, OH 43210
Phone: (614)422-2326 or 422-8746

Applications should include a resume, a statement of research record and interests and the names of at least three persons whom we may contact for recommendations. The closing date for applications is December 23, 1983; appointments will be effective no later than October 1, 1984. Additional information can be obtained by writing or calling the search committee chairman.

The Ohio State University is an equal opportunity/affirmative action employer.

Structural Geology/Tectonics—University of Michigan. The Department of Geological Sciences invites applications for a tenure-track position to begin September 1, 1984. We are looking for an outstanding researcher with broad interests in the study of the history, structure, and evolution of the continental crust. We are willing to consider expertise on any scale—microscopic to global—but have preference for those that link several. Teaching responsibilities will include a structural geology course for concentrators, plus other courses selected from introductory geology, field, and graduate offerings according to the candidate's interests. Interested persons should send a resume, names of five persons from whom the Department may request letters of recommendation, and a brief statement of research interests to: Prof. Rob Van der Voo, Chairman, Department of Geological Sciences, 1006 C.C. Little Building, Ann Arbor, MI 48109–1063. The search will close January 10, but later applications may be considered.

The University of Michigan is a non-discriminatory, affirmative action employer.

Princeton University/Faculty Appointment. The Department of Civil Engineering at Princeton University invites applications for a faculty appointment in the Water Resources Program beginning September 1984. Responsibilities include graduate and undergradute teaching in fluid mechanics, surface water hydraulics, and numerical methods, and development of and participation in a research program related to surface and subsurface hydraulic and hydrologic systems. Candidates must have a Ph.D. degree with demonstrated teaching ability and scholarship. Submit resume and three references to George F. Pinder, Chairman, Department of Civil Engineering, Princeton University, Princeton, NJ 08544.

Princeton University is an affirmative action/equal opportunity employer.

Louisiana State University/Tenure-Track Faculty Positions in Geology. The Department of Geology is expanding from 16 to 35 faculty with four positions open Fall 1984 and one position (Field Camp Director) open January 1984. Candidates must have the Ph.D. and have active research in progress that might be applied to studies of basins. Specialties of primary interest are field geology, theoretical seismology, hydrogeology, and organic geochemistry; however, other disciplines will also be considered with quality of research being the primary factor in applicant selection. All faculty in the Department are required to conduct research leading to publications and to provide quality instruction. The Department will expand into a new building January 1986.

For consideration send resume, three letters of reference and a description of research to Lyle McGinnis, Faculty Search, Department of Geology, Louisiana State University, Baton Rouge, LA 70803–4101. Search will remain open until positions are filled.

Northern Illinois University/Geophysicist. The Department of Geology seeks to fill a tenure-track position in geophysics beginning August 15, 1984. Candidates with experience in applied seismology are particularly encouraged to apply. Appointment will be at the rank of Assistant Professor. Post-doctoral experience is considered important, and the successful candidate will be expected to develop an aggressive research program, teach at both the graduate (Ph.D. and M.S.) and undergraduate levels, and interact with an active group of faculty and students in geophysics. Send resume, statement of research interests, and the names of three references to: Chair, Geophysics Search Committee, Department of Geology, Northern Illinois University, DeKalb, IL 60115. Application deadline is February 1, 1984.

Northern Illinois University is an equal opportunity/affirmative action employer.

Oceanographic Microbiologist/Oregon State University. The College of Oceanography at Oregon State University has an assistant professorship position open for an oceanographic microbiologist. The appointee will be expected to develop a program of grant-funded research in the area of marine microbiology. Opportunities will be available for teaching of classes and seminars in marine microbiology and biological oceanography and for supervision of graduate students. Candidates should hold a Ph.D. in biological oceanography, microbiology, or related discipline, and have postdoctoral research experience specifically with marine microbes. Salary: $27,000–$35,000, negotiable. Submit resume and names of three references before 15 January 1984 to: Dr. G. Ross Heath, Dean, College of Oceanography, Oregon State University, Corvallis, Oregon 97331.

Affirmative Action/Equal Opportunity employer.

Department of Atmospheric Science/State University of New York at Albany. Applications are invited for a tenure-track assistant professorship beginning September 1984. We seek a person who can complement one or more existing areas of research in physical meteorology in the department, which include atmospheric electricity, aerosol and fog physics, and atmospheric radiation. Excellent facilities are available for research support, including an East Coast, synoptic-scale lightning location detection system, McIDAS (Man-computer Interactive Data Access System), a fog field station, and an electron microscope.

Applicants must have a Ph.D. degree (or completed all requirements therefore) and will be expected to teach at the graduate and undergraduate level and pursue a vigorous research program funded by appropriate external agencies. A curriculum vitae, a brief statement of research interests, and the names of three individuals who may be contacted for references should be sent by February 1, 1984 to:

Richard E. Orville, Chairman
Department of Atmospheric Science
State University of New York at Albany
Albany, NY 12222

SUNYA is an Affirmative Action/Equal Opportunity Employer. Minorities and women are encouraged to apply.

University of California, Riverside/Geology (with emphasis on petrology). Assistant Professor opening beginning 1 July 1984. The appointment is ladder faculty position. Appointee would teach at both undergraduate and graduate levels (M.S. and Ph.D.) and should be able to teach several of Petrology, Mineralogy, Geochemistry, Crystallography, Field Geology, Physical Geology. Ph.D. required. In addition to teaching, research and service are required of faculty members at the University of California. Applicants should submit a current curriculum vitae with names and addresses of three people who have agreed to provide references. Applications received by February 1, 1984, will be given full consideration. Applications may be accepted until successful candidate is appointed. Send applications to: Dr. Lewis H. Cohen, Search Committee Chair, Department of Earth Sciences, University of California, Riverside, California, 92521.

The University of California is an Equal Opportunity/Affirmative Action Employer.

Staff Scientists/Systems Analysts. Research and Data Systems, Inc. has openings available for Staff Scientists, Systems Analysts and Programmer/Analysts to work in areas involved in the processing and application of data from satellite based remote sensing systems. Particular needs involve the analysis and processing of Earth Radiation Budget, Microwave, AVHRR and LANDSAT data. Needs also exist in the areas of interactive image graphics, software engineering, realtime processing and satellite data communications. Successful candidates will have an advanced degree in meteorology, physics, engineering, mathematics, or computer sciences. Hardware background should include IBM, DEC, CYBER or HP-1000 equipment. Send resume in confidence to:

Research and Data Systems, Inc.
10300 Greenbelt Road, Suite 206
Lanham, Maryland 20706
Telephone: (301) 390-6100

Hydrogeology/University of Illinois at Urbana-Champaign. The Department of Geology has reinstituted its search for a hydrogeologist to fill a permanent, tenure-track faculty position. The appointment will be at the Assistant Professor level. Salary is negotiable. A Ph.D. is required. Starting date will be August 21, 1984. The successful candidate will have a demonstrated background in one or more of the following areas of hydrogeology: basin analysis, flow in porous media, or chemical interactions between groundwater and rocks and will be expected to teach one or more graduate courses in hydrogeology, to participate in our undergraduate instructional program, and to maintain and enhance our existing strong research program in hydrogeology. For equal consideration, application including the names of three referees should be sent by:

Prof. R. James Kirkpatrick
Department of Geology
245 Natural History Building
1301 W. Green Street
Urbana, Illinois 61801
Tele: (217) 333-3542

The University of Illinois is an affirmative action/equal opportunity employer.

National Center for Atmospheric Research/Visitor Applicants. At the High Altitude Observatory, Visitor Appointments are available for new and established Ph.D.'s for up to one year periods to carry out research in solar physics, solar-terrestrial physics, and related subjects. Applicants should provide a curriculum vitae including education, work experience, publications, the names of three scientists familiar with their work, and a statement of their research plans. Applications must be received by January 15, 1984, and they should be sent to: HAO Visitor Committee, High Altitude Observatory, National Center for Atmospheric Research, P.O. Box 3000, Boulder, Colorado 80307.

NCAR is an Equal Opportunity/Affirmative Action Employer.

The State University of New York at Binghamton/Petrologist. The State University of New York invites applications for a tenure-track faculty position in igneous or metamorphic petrology beginning August, 1984. Appointment will be at the level of assistant professor. Candidates must have a Ph.D. degree by this date, and also the potential to develop a productive research program, as well as teach at the undergraduate and graduate levels.

Applicants should send a resume and names of at least three persons who can be contacted for references to:

Thomas W. Donnelly
Department of Geological Sciences
State University of New York
Binghamton, New York 13901

The State University of New York at Binghamton is an affirmative action/equal opportunity employer. The closing date for this position is December 15.

Case Western Reserve University/Faculty Position in Water Resource Systems Engineering. The Systems Engineering Department invites applications for a tenure track faculty position in the area of Water Resource Systems Engineering. The undergraduate and graduate programs in water resources at Case Western Reserve University are managed through the Civil Engineering and Systems Engineering Departments respectively. Because of the close interaction between the two programs, a joint appointment between the Systems and Civil Engineering Departments is possible. At the present, research in the water resource systems engineering area is focused on water planning, management and policy analysis, hierarchical-multiobjective decision making, groundwater quality management, risk assessment, and decision support systems. The applicant should have a doctorate and a strong interest in undergraduate and graduate teaching as well as a commitment to develop a strong research program in his/her area of expertise.

Please send a resume and names of references to:

Professor Yacov Y. Haimes, Chairman
Systems Engineering Department
Case Western Reserve University
Crawford Hall
Cleveland, Ohio 44106

CWRU is an equal opportunity/affirmative action employer.

Geophysicist Tenure-Track Appointment/Department of Geology, University of Toledo. The position is effective September 1, 1984. Individuals with strong background in exploration geophysics—applied geophysics are of primary interest although other specializations will be considered. The Ph.D. is required as well as a strong commitment to effective teaching and research. The department has modern facilities and offers B.S., B.A., and M.S. degrees to approximately 60 undergraduate and 30 graduate students. The faculty consists of eight full time and five adjunct professors actively involved in a wide range of research projects. Interested persons should submit a letter of application, resume, transcripts, and three letters of recommendation to: Stuart L. Dean, Chairman of Search Committee, Department of Geology, University of Toledo, Toledo, Ohio 43606, phone (419) 537-2246 or (419) 537-2009.

University of Toledo is an equal opportunity/affirmative action employer.

Meteorologist/The City College of The City University of New York. The Department of Earth and Planetary Sciences invites applications for an anticipated opening in meteorology. The appointment will start September, 1984. Applicants should have completed the Ph.D. by the time of appointment and have a strong background in synoptic meteorology and computer applications. In addition, the individual should have an interest in atmospheric chemistry or pollution as applied to urban areas, or physical oceanography. The person hired will be required to teach courses in meteorology, and possibly physical oceanography as well as develop and maintain an active research program. Participation in the C.U.N.Y. Ph.D. Program in Earth and Environmental Sciences is anticipated. Rank and salary will be commensurate with experience. Send resume, transcripts and three letters of reference by November 30, 1983 to Professor Dennis Weiss, Chairman, Department of Earth and Planetary Sciences, the City College, 138 Street and Convent Avenue, New York, N.Y. 10031.

The City College of the City University of New York is an equal opportunity affirmative action employer.

University of Wisconsin-Milwaukee/Hydrologic Modeler. The Department of Geological and Geophysical Sciences at the University of Wisconsin-Milwaukee invites applications for a probable tenure-track position of Assistant Professor beginning in Fall, 1984, to join a broad program in hydrogeologic, geological, atmospheric and geophysical sciences. Applicant's primary strength should be in the application of numerical models to ground water flow and chemical transport systems. A strong chemical background or modeling experience with flow in fractured media or contaminant migration would be helpful. Further, ability to apply modeling techniques to problems in other aspects of the geosciences will be important.

The successful candidate will be expected to teach an applied senior level course in the theory and application of finite element, finite difference methods to problems of hydrology and geophysics. The candidate is expected to develop additional graduate level courses in hydrology and to teach general geology at the undergraduate level. Ability to teach geophysical fluid dynamics would be valuable.

Research programs at UWM include lake infiltration into aquifers, use of aquifers for compressed-air storage, Great Lakes contamination and sediment processes, the use of applied geophysics in determining hydraulic properties and flow, and severe-storm modeling. Facilities include a Great Lakes Research Center with research vessels and pier facilities, an Urban Research Center and a rural field station.

Candidates should forward resumes, complete transcripts and three letters of recommendation to Professor D.S. Cherkauer, Chair, Department of Geological and Geophysical Sciences, University of Wisconsin-Milwaukee, WI 53201. Salary range has not yet been formally approved, but will probably be in the $25,000-$29,000 range. Closing date for applications is January 31, 1984.

UWM is an affirmative-action, equal opportunity employer.

Hamilton College/Faculty Position. Applications are invited for a tenure-track position starting September 1984 at the Assistant Professor level. This position will expand the department from three to four faculty members. We seek a person with a PhD who is strongly oriented toward undergraduate teaching and whose field of training and interests are in any of the following fields: geophysics, low-temperature geochemistry, oceanography. Highly qualified candidates in other areas will also be considered. The successful candidate will be expected to contribute to introductory courses offered by the department, teach advanced undergraduate courses, and maintain a research program.

Hamilton is a private, coeducational liberal arts college with 1600 students. The department has an active program with 10-15 majors in each class, excellent facilities and equipment, and a strong emphasis on field work.

Candidates should send letters of application, resumes, transcripts, and three letters of recommendation to: Donald B. Potter, Chairman, Department of Geology, Hamilton College, Clinton, NY 13323.

Hamilton College is an equal opportunity employer. Women and minorities are encouraged to apply.

Ohio State University/Structural Geologist. The Department of Geology and Mineralogy, The Ohio State University, invites applications for a tenure-track position for a structural geologist with a strong background in quantitative analysis of field data and research interests in regional tectonics or tectonophysics. The successful applicant will be expected to participate in the undergraduate program and give graduate courses in his/her area of expertise, conduct research, supervise graduate students, and interact with other departmental programs in regional geology and geophysics. Preference will be given to candidates with post-doctoral or industrial experience. Rank and salary commensurate with experience and research record. Please send applications or nominations as soon as possible to:

Dr. Ralph R.B. von Frese
Chairman, Search Committee
Department of Geology and Mineralogy
The Ohio State University
Columbus, OH 43210
Phone: (614) 422-5635 or 422-2721

Applications should include a resume, a statement of research interests and the names of at least three persons whom we may contact for recommendations. The closing date for applications is December 23, 1983; appointments will be effective no later than October 1, 1984. Additional information can be obtained by writing or calling the search committee chairman.

The Ohio State University is an equal opportunity/affirmative action employer.

Atmospheric Physicist/Northern Arizona University. Tenure-track assistant professor available January 10, 1984 (or August, 1984) in an eleven-man Physics Department with a joint appointment in Computer Science. Teaching is at the undergraduate level with approximately one-half time devoted to teaching courses related to laboratory applications of computers. Knowledge of FORTRAN at least one assembly language, and fundamental digital logic is essential. Approximately one-half time will be devoted to teaching and research in Physics. Areas of research interest could include radiative transfer, mesoscale dynamics, orographic flows and/or meteorological/environmental instrumentation including remote sensing. Send a complete resume, statement of research interest and professional goals and names of three references to: Dr. Kenneth Odell, Chairperson, Department of Physics, Box 6010, Northern Arizona University, Flagstaff, AZ 86011.

Applications received prior to November 30 will receive full consideration. Ph.D. required. Academic salary range $20,000–25,000.

NAU is an Affirmative Action/Equal Opportunity Employer.

Igneous/Metamorphic Petrologist or Structural Geologist/Hobart and William Smith Colleges. The Department of Geoscience of these private, coordinate, liberal arts colleges seeks applicants for a full-time, tenure-track position for September, 1984. We need a field-oriented, igneous or metamorphic petrologist or structural geologist, a person committed to excellence in teaching and to stimulation of undergraduate research. Ph.D. required and teaching experience desirable. Teaching includes introductory courses, mineralogy, petrology and structure plus participation in the Colleges' general curriculum. Research encouraged and supported. Submit Vitae and three letters of recommendation to: Donald L. Woodrow, Department of Geoscience, Hobart and William Smith Colleges, Geneva, NY 14456. Applications from women and members of minority groups encouraged.

Hobart and William Smith Colleges are equal opportunity/affirmative action employers.

Meteorologist/U.S. Department of Commerce. The Geophysical Fluid Dynamics Laboratory of NOAA in Princeton, NJ seeks a scientist with a background in diagnostic studies of the atmospheric general circulation system. Research involves application of modern analysis methods, e.g., spectral, empirical orthogonal function, and space-time wave analysis to observational atmospheric and oceanic data for extracting diagnostic information on the behavior of atmospheric general circulation and climatic responses. The incumbent performs definitive comparative studies of the results from long time integration of complex and comprehensive climate models. Position is in the competitive service and will be filled at the GS-13 level with annual salary range of $34,930 to $45,406. Qualifications: B.S. or higher degree in meteorology with three or more years of professional experience which shows possession of selective factors. One year of experience must have been comparable to the GS-12 level in the Federal service. Graduate education may be substituted in part for experience requirements. Selective Factors: 1)Knowledge of atmospheric general circulation theory and climate dynamics in global and regional climate systems, including large-scale transient eddy properties and the role of local sources and sinks of momentum, kinetic energy, and heat and vorticity in maintaining stationary components of climatic structure. 2)Knowledge of the methods of comprehensive model building. 3)Knowledge of modern data analysis techniques—e.g., spectral, empirical orthogonal function, space-time wave propagation—as applied to large, heterogeneous data sets. To Apply: Current or former Federal employees submit SF-171, CD-362, and OPM Form 1386. For forms call (303) 497-6332 or FTS 320-6332. Others submit a CN-1300 package and Form 1386, both obtainable from Federal Job Information Centers. Send to NOAA/MASC, Personnel Div (AT/MC25), ATTN: Mr. M. Mann, 325 Broadway, Boulder, CO 80303. Vac. No. MASC/NOAA 83A-72. Closes November 18, 1983 or CALL FOR EXTENSION.

An Equal Opportunity Employer.

Geophysics-Tectonophysics/University of Wyoming. Applications are invited for a tenure track position at the Assistant Professor level in the Department of Geology and Geophysics. Candidates should have teaching and research interests in such areas as tectonophysics, thermal modeling and/or plate tectonics. The successful applicant will join an established Ph.D. level geophysics program. Duties will include teaching undergraduate and graduate level geophysics courses, and *establishing a vigorous* research program. Excellent opportunities exist for cooperation with mathematics; the Mathematics Department includes a strong numerical methods group with interests in geophysics. *Send resume,* transcripts and three letters of recommendation by January 15, 1984 to Peter N. Shive, Dept. of Geology/Geophysics, PO Box 3006, University of Wyoming, Laramie, WY 82071.

The University of Wyoming is an equal opportunity/affirmative action employer.

RESEARCH FACULTY POSITION

DEPARTMENT OF OCEANOGRAPHY
NAVAL POSTGRADUATE SCHOOL

An (adjunct) research faculty position in physical/dynamical oceanography is immediately available; it is expected to continue for several years. A PhD in physical oceanography, meteorology, geophysical fluid dynamics, applied mathematics, physics or engineering is required. The position is dedicated to a program, in synoptic/mesoscale ocean prediction over an open domain, called OPTOMA (Ocean Prediction Through Observations, Modeling, and Analysis). OPTOMA is a joint NPS/Harvard program, sponsored by ONR, which has been in progress for a year-and-a-half. A series of ocean prediction experiments in the eddy field of the California Current System is planned over the next several years. The scientific responsibilities of the position involve: (1) running simulations and prediction experiments with, and evolving, the Harvard statistical-dynamical (a quasi-geostrophic model interacting with a statistical objective analysis) model, (2) participating in seagoing, real-time ocean prediction experiments, often as a chief scientist, (3) conducting data analysis studies, and (4) developing leadership in the physical interpretation of synoptic/mesoscale processes. Hence, a strong background in ocean dynamics and an active involvement in numerical modeling are required. In summary, this is an important scientific opportunity for someone interested in combining synoptic work at sea with theory and numerical modeling.

Assets of the Department include a research vessel with ready access to an exciting region of the ocean, free access to an IBM 333 with excellent graphics capabilities, and proximity to the Fleet Numerical Oceanography Center and the Naval Environmental Prediction Research Facility. Links exist to NORDA, the Naval Oceanographic Office, other Navy labs, and NOAA activities, as well as other academic institutions. Altogether, there are over 100 practicing physical oceanographers and meteorologists in the Monterey area. Finally, the Monterey area has spectacular climate and scenery.

We will welcome applications on a continuing basis. However, the initial closing date will be *9 December 1983*. Send a curriculum vitae; statement of professional interests; and names, addresses, and telephone numbers of at least three references to:

Professor Christopher N. K. Mooers,
Chairman, Oceanography Department, Code 68Mr
Naval Postgraduate School Monterey, CA 93943
Telephone: (408) 646-2678

The Naval Postgraduate School is an Affirmative Action/Equal Opportunity Employer.

Trinity University/Igneous or Metamorphic Petrologist. The Department of Geology at Trinity University is seeking candidates to fill a tenure track position with a specialty in igneous or metamorphic petrology beginning August, 1984. The appointment will be at the Assistant Professor level and the candidate must possess the Ph.D. degree. Priority will be given to those individuals with expertise in optical mineralogy and petrography. This position requires a person with a commitment to excellence in teaching as well as a desire to engage in an ongoing research program. Teaching will be at the undergraduate level and will include courses in physical geology, petrology, and optical mineralogy.

Trinity University is an independent privately supported institution committed to excellence in the liberal arts and selected professional programs including engineering. Present enrollment is 3,000, of which 2,450 are undergraduates. The Department of Geology has five faculty members and fifty majors. Trinity is located in San Antonio, Texas, a metropolitan area of approximately one million.

Closing date is January 15, 1984. Applications should include a resume, recent transcript, and the names of three references, and should be sent to: Robert L. Freed, Search Committee Chairman, Department of Geology, Trinity University, 715 Stadium Drive, San Antonio, Texas 78284.

Trinity University is an Equal-Opportunity/Affirmative-Action Employer.

Texas A&M University/Deputy Department Head. The Department of Oceanography in the College of Geosciences at Texas A&M University is seeking a deputy department head to assist in the academic and administrative functions in the Department. Duties will involve 75 percent administration and 25 percent research or teaching on a 12-month appointment basis. This is a tenure track position and will be filled at an academic level commensurate with the experience of the applicant. Applicant must have demonstrated administrative ability, an established record in research and an interest in teaching at both undergraduate and graduate levels of Oceanography. Closing date for applications is 15 December 1983. Effective date of this appointment will be 1 January 1984.

TAMU is an equal opportunity/affirmative action employer.

University of Texas at Austin/Getty Chair. The Department of Geological Sciences seeks a person at the rank of full professor to occupy the recently endowed Getty Chair effective September 1, 1984. Teaching obligations include one undergraduate or graduate course each semester and the supervision of graduate students in the areas of the person's interest. A willingness to teach courses for non-majors on occasion is desirable. The person's field of research must be one that is related in a broad sense to the exploration for hydrocarbons. The Getty endowment will provide the chair holder with modest funds for support of travel and research activities. Applicants should submit a detailed resume, names and addresses of five references, and a statement of teaching and research interests by February 1, 1984 to: Dr. Earle F. McBride, Chairman, Department of Geological Sciences, P.O. Box 7909, Austin, Texas 78712–7909.

The University of Texas at Austin is an Equal Opportunity/Affirmative Action Employer.

Tarleton State University/Associate Director—Hydrology. Part of the Texas A&M System, is offering a B.Sc. Degree in Hydrology as of the Fall, 1983 Semester. This is the only such degree in the State of Texas. The Associate Director we are seeking must be an enthusiastic individual able to work with the Director in sharing the administrative load, and developing this program into regional and national prominence. This will be a tenure-track appointment, rank and salary negotiable, Ph.D. required. Substantial funding available for facilities construction. Applications are sought from outstanding hydrologists, water resources engineers and scientists, including hydrotoxicologists. Applicants should send resume and names of three references by February 1, 1984, to Dr. Roger DeWiest, Director of Hydrology, P.O. Box T-69, Tarleton Station, Stephenville, Texas 76402. Telephone 817-968-9864 (63). Position must be filled as of April 1, 1984.

Tarleton State University is an affirmative action, equal opportunity employer.

National Center for Atmospheric Research/Ph.D. Researcher. NCAR's Atmospheric Chemistry and Aeronomy Division seeks experienced Ph.D. researcher with record of sustained productivity in theory and modelling of atmospheric chemistry. Primary interest is in gaseous photochemistry and coupled chemical/meteorological models, but all specialties will be considered along with scientific breadth. Appointment is at Scientist III or Senior Scientist level. Apply with resume to Dr. R. Cicerone, National Center for Atmospheric Research, P.O. Box 3000, Boulder, Colorado 80307, by December 20, 1983.

Equal Opportunity Employer M/F.

Research Observer/U.S. Department of Commerce. Position in Barrow, Alaska. Conducts scientific measurements at the NOAA Baseline Observatory in Barrow, Alaska. Will make measurements of atmospheric Co2, ozone, aerosols, other trace constituents, and meteorological parameters. This position is an electronics specialist (instrument). Responsibilities are calibration and maintenance of the Observatory instruments and NOVA minicomputer. We seek applicants with electronics technician background with at least 4 years of experience or electronics engineers with at least 2 years experience. The experience should be specialized in electronic instrumentation calibration and maintenance.

This is a 15–24 month appointment. Duty station for the first two months will be in Boulder, Colorado for orientation and training, then at Barrow, Alaska. NOAA will supply bachelor quarters at reasonable cost in Barrow. The Observatory is within 6 miles of Barrow, a community of about 2000 people. The measurements supply information for current atmospheric research into climate and climate change. We offer an adventure as well as good salary (about $30,000-$40,000 per year, depending on qualifications and experience). For more information, contact Mr. Bernard Mendonca, U.S. Dept. of Commerce/NOAA, 325 Broadway, Boulder, Colorado 80303; telephone FTS 320-6733 or Commercial (303) 497-6733.

NOAA is an equal opportunity employer.

Faculty Position/Arizona State University Department of Geology. Applications are invited for an anticipated tenure-track faculty position at the assistant professor level, beginning in August of 1984.

The selected candidate will be expected to display excellence in teaching and to develop a vigorous program of research on important geological problems. Possible research areas which would complement or extend existing strengths in the department include solid earth/crustal geophysics, seismology, and mineral physics.

Please send a detailed statement of research and teaching interests and a resume with names of four references by January 15, 1984 to Paul Knauth, Chairman, Department of Geology, Arizona State University, Tempe, AZ 85287

Arizona State University is an equal opportunity/affirmative action employer.

Arizona State University/Geochemistry Research Specialist. To operate and modify automated SEM facility for aerosol particle anlaysis in atmospheric geochemistry research. Software development and SEM/EDS experience necessary. Ph.D. optional. Competitive salary. Send resume, statement of experience to personnel, Arizona State University, Tempe, Arizona 85287 and names of three references to Dr. P.R. Buseck, Depts. of Geology and Chemistry.

ASU is an EO/AA employer.

The University of New Mexico/Mass Spectrometry. The Department of Geology, University of New Mexico, Albuquerque is seeking applicants for a research associate position in the stable isotope laboratory. The position includes responsibility for operation and maintenance of mass spectrometers and high vacuum extraction systems, sample preparation and isotopic analyses. The position also provides opportunities for collaborative research in isotope geochemistry leading to publication. A Ph.D. in geochemistry, inorganic chemistry, or physical chemistry with research experience involving mass spectrometry and high vacuum technology is required. Send a letter of application, resume, and the names and addresses of three individuals willing to serve as references to: Crayton J. Yapp, Department of Geology, University of New Mexico, Albuquerque, NM 87131. Closing date for applications is February 1, 1984. The availability of this position is contingent on final budget approval.

The University of New Mexico is an equal opportunity employer.

Louisiana State University/Chas. T. McCord, Jr. Endowed Professorship in Hydrocarbon Exploration: The Geology Department is seeking an internationally recognized leader in some research specialty critical to the search for oil and gas to fill the Chas. T. McCord, Jr. Endowed Professorship. Applicants are expected to maintain scholarly research in their area of specialty. Rank at Full Professor level with salary competitive with endowed professorships at other major research universities. For consideration send resume, three letters of reference, and a description of future research programs to Lyle McGinnis, Faculty Search, Department of Geology, Louisiana State University, Baton Rouge, LA 70803–4101. Search will remain open until position is filled.

LOUISIANA STATE UNIVERSITY IS AN AFFIRMATIVE ACTION/EQUAL OPPORTUNITY EMPLOYER.

University of Iowa/Faculty Positions. The Department of Physics and Astronomy anticipates two openings for tenure-track assistant professors or visiting faculty at any level in August 1984. In exceptional cases a term or tenured appointment at the associate professor or professor level will be considered. Preference for one position will be given to an experimentalist in intermediate or high energy physics. Current research interests in the department are radio and optical astronomy and the following specialties in physics: atomic, condensed matter, elementary particle, laser, nuclear, plasma, and space physics. Faculty duties include undergraduate and graduate teaching, guidance of research students and personal research. Interested persons should submit a resume and a statement of research interests and arrange for three letters of recommendation to be sent to Search Committee, Department of Physics and Astronomy, The University of Iowa, Iowa City, IA 52242.

The University of Iowa is an equal opportunity/affirmative action employer.

Ohio State University/Seismologist-Tectonophysicist. The Department of Geology and Mineralogy, The Ohio State University, invites applications for a tenure-track position for a geophysicist with research interests in seismology and/or tectonophysics. The successful applicant must be prepared to assist in teaching exploration geophysics courses, advanced topics in his/her specialty, conduct research, and supervise graduate students. Preference will be given to candidates with post-doctoral or industrial experience. Rank and salary commensurate with experience and research record. Please send appplications or nominations as soon as possible to:

Dr. Ralph R.B. von Frese
Chairman, Search Committee
Department of Geology and Mineralogy
The Ohio State University
Columbus, OH 43210
Phone: (614) 422-5635 or 422-2721

Applications should include a resume, a statement of research interests and the names of at least three persons whom we may contact for recommendations. The closing date for applications is December 23, 1983; appointments will be effective no later than October 1, 1984. Additional information can be obtained by writing or calling the search committee chairman.

The Ohio State University is an equal opportunity/affirmative action employer.

University of Wisconsin-Parkside/Tenure-track Position. The Geology Program at the University of Wisconsin-Parkside invites applications for a tenure-track position at the assistant-professor level to begin in August 1984. The successful applicant will be expected to teach undergraduate courses in one or more of the following areas: hydrogeology, low temperature geochemistry, environmental geology; carry out a productive research program in his/her specialty; and share the teaching load in introductory geology courses. The Ph.D. or equivalent is required. Submit a resume, transcripts, 3 letters of reference, and a statement of research and teaching interests by January 31, 1984 to:

Professor Gerald A. Fowler
Geology Program
University of Wisconsin-Parkside
Box No. 2000
Kenosha, Wisconsin 53141

We will interview at the G.S.A. meeting in Indianapolis.

The University of Wisconsin-Parkside is an affirmative action/equal-opportunity employer.

Oregon State University/Fisheries Oceanography. Applications are invited for a 12-month, tenure-track position as Assistant Professor in the College of Oceanography with a joint appointment in the Department of Fisheries and Wildlife. Applicant must have demonstrated ability to conduct independent research and obtain research funding in the areas of ecology of marine fishes or nekton. Workers with interests in ecology, fisheries oceanography, or population biology of nekton will be considered. Applicant must have Ph.D. Postdoctoral experience desirable.

The appointee will be expected to teach courses in fisheries oceanography or in the ecology of marine nekton, to supervise graduate students, and to develop a program of grant-funded research. Salary: $27,000–35,000, negotiable. Application material, including a brief statement of research plans and the names of three references, should be submitted not later than 31 January 1984 to: G. Ross Heath, Dean, College of Oceanography, Oregon State University, Corvallis, Oregon 97331.

Affirmative Action/Equal Opportunity employer.

OCEANOGRAPHER

The U.S. Coast Guard Research and Development Center, Groton, CT, has an immediate opening for an Oceanographer (GS-1360-11). The incumbent serves as task manager providing theoretical and computational assistance for the development of specified surface drift computer models. Translates concepts for the physical interaction of surface movement into operating time-dependent predictive computer programs.

Candidates should be degreed and possess at least 3 years of professional experience in Physical Oceanography. Additional attributes would include competence in computer science, experience in writing technical reports, experience in programming minicomputers in FORTRAN and BASIC, knowledge of statistical practices and analysis techniques as well as excellent oral communication skills. Field work involving stays of a month or more at any location in the continental US including Alaska and Hawaii, is required.

This is a Federal Civil Service position. Applicants must submit OPM form 1282 (Application for Federal Employment). Apply to Office of Personnel Management, Boston Area Office, 3 Center Plaza, Boston, MA 02108. Applications must be received by December 16, 1983. Application forms and information may be obtained by telephoning (203) 444-8202.

UNITED STATES COAST GUARD

Equal Opportunity/Affirmative Action Employer

University of Oxford/Research Assistantship—Grade IA. Salary £7190-£11,615

Applications are invited for a NERC supported Research Assistantship to investigate the use of satellite altimetric measurements in oceanography and help in the design of observing systems for the World Climate Research Programme. Use will be made of models of ocean circulation on the CRAY-1 computer accessed from the Oxford work station.

Candidates should ideally have a Ph.D. in geophysical fluid dynamics, applied math or physics. The position, which is available to March 1986, will commence as soon as possible.

Applications, giving details of qualifications and research experience, together with the names and addresses of two referees, should be sent to Dr. D.L.T. Anderson, Dept. of Atmospheric Physics, Clarendon Laboratory, Oxford OX1 3PU, by 25 November 1983.

PHYSICAL OCEANOGRAPHER/University of Rhode Island. The Graduate School of Oceanography at the UNIVERSITY OF RHODE ISLAND invites applicants for an Assistant or Associate Research Professor position. We are particularly interested in candidates with theoretical or numerical modeling experience in one or more of the following areas of research: geophysical fluid dynamics, dynamics of equatorial oceans, oceanic transport processes, and climate and the oceans. Only limited start-up funds are available so candidates must have a demonstrated ability to raise their own funding. Please send application including a statement of research interests and names of three references by December 15, 1983 to: Professor Melvin Stern, Graduate School of Oceanography, UNIVERSITY OF RHODE ISLAND, Kingston, Rhode Island 02881.

An AA/EOE m/f.

University of Rhode Island/Marine Research Associate III. A postdoctoral research associate position is available starting January 1, 1984, for studies of the western Sargasso Sea from the subtropical convergence to the Gulf Stream. The research involves the processing and analysis of satellite thermal IR digital data. The primary scientific emphasis will be on mesoscale near surface dynamics and on air/sea interaction in the region and will be coupled to in situ data from several on-going projects. Facilities include dedicated VAX 11/780 image processing system with large historical digital data base and extensive data acquisition program of the Sargasso Sea. Submit resume and 3 professional references by December 15, 1983 to: Peter Cornillon, Marine Research Associate III Position, UNIVERSITY OF RHODE ISLAND, P.O. Box 357, Kingston, Rhode Island 02881–0357.

An AA/EOE m/f.

Chair/Northern Illinois University/Chair. Applications are invited for the position of Chair of the Department of Geology. We seek candidates who have an established commitment to research and who are interested in the challenge of leading a young and growing department which has just recently established a Ph.D. program. The department is committed to the further development of a strong Ph.D. program and is looking for candidates who would share that commitment. We seek the strongest possible candidates without regard to specialty; however, candidates from the areas of hydrogeology, hydrogeochemistry or geophysics are particularly encouraged to apply.

Rank and salary for the position are negotiable. Send resume and statement of interest to Dr. M.P. Weiss, Chair, Search Committee, Department of Geology, Northern Illinois University, DeKalb, IL 60115.

Northern Illinois University is an affirmative action/equal opportunity employer.

GEOCHEMIST/PHYSICAL INORGANIC CHEMIST

A postdoctoral position is available in the Chemistry Division of Argonne National Laboratory for a person with a background in geochemistry or physical inorganic chemistry. The research area involves microcalorimetric and related studies of reactions important for the geochemistry of transuranium elements. To apply, please send resume to: Walter D. McFall, Box-D-CHM-80, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439.

An Equal Opportunity/Affirmative Action Employer.

Boston University/Faculty Position. The Astronomy Department at Boston University expects to have a faculty position available beginning either January or September 1984, extending at least through the 1984/85 academic year. Applicants are sought who have teaching experience and who have a proven research record as evidenced by publications and recommendations. Research programs in the department include ionospheric and magnetospheric physics, galactic astronomy, and extragalactic and high energy astrophysics. Applicants with research programs in any of these areas will be considered; however, preference will be given to those with experimental or observational interests.

Equal consideration will be given to individuals wishing to start in January or September 1984. Depending on the future availability of funds, this position may be converted to a permanent line leading to eventual tenure.

Please send a curriculum vitae, names of three persons who can provide an evaluation of your teaching and research and a brief statement of current research interests to:

Kenneth Janes, Chairman
Astronomy Department
Boston University
725 Commonwealth Avenue
Boston, MA 02215
(617) 353-2627

Boston University is an Equal Opportunity/Affirmative Action Employer.

POSITIONS WANTED

Geochemist/geologist. Ph.D., 6 years of experience in trace element geochemistry, volcanology, hydrothermal processes, water-rock interaction, with field/lab techniques on land or at sea. Also teaching experience at university level. Seeks Research/Teaching/Industrial position in the Washington, D.C. area. Resume on request. American Geophysical Union, 2000 Florida Avenue, N.W., Box 019, Washington, D.C. 20009.

TRANSLATORS. Free lance, Russian to English with expertise in seismology, tectonics, mathematical aspects of geology, aeronomy, dynamic meteorology or physical oceanography. Excellent knowledge of Russian and ability to write idiomatic English required. Write to: Scripta Publishing Co., 7961 Eastern Ave., Silver Spring, MD 20910.

STUDENT OPPORTUNITIES

Graduate Teaching and Research Assistantships in Marine Environmental Sciences and Coastal Oceanography. Opportunities for graduate study with graduate teaching and research assistantships available for students interested in the M.S. program in Marine Environmental Sciences and the Ph.D. program in Coastal Oceanography. Awards cover tuition and academic year stipends up to $7,290. Additional summer support also available up to $3000. Write: Graduate Program Chairman, Marine Sciences Research Center, State University of New York, Stony Brook, N.Y. 11794.

State University of New York does not discriminate on the basis of race, sex, religion, national origin, age, physical disability or marital status, in admissions, hiring, and treatment of either students or employees.

University of Miami/Graduate Research Assistantships in Physical Oceanography and Meteorology. The Division of Meteorology and Physical Oceanography, School of Marine and Atmospheric Science, University of Miami, invites applications from students in science or engineering with a strong background in physics and mathematics and an interest in either the atmospheres, the ocean or their mutual interaction. Successful applicant may pursue either a M.S. or Ph.D. involving work in a wide range of observational/experimental or theoretical research. Remuneration includes tuition ($5,280, first year) plus a yearly stipend of $9,360 for applicants entering the M.S. program and $11,050 for students in the Ph.D. program. Research Assistantships begin 1 September, 1984, but summer research work may be available earlier to some accepted students. For details and/or application write: Dr. Friedrich Schott, Division of Meteorology and Physical Oceanography, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Cswy, Miami, FL 33149.

GRADUATE STUDENT
NASA TRAINEESHIPS

The Florida State University is accepting applications from prospective graduate students for participation in its NASA sponsored Traineeship Program in Oceanography: Remote Sensing Techniques and Physics of Air-Sea Interaction. The stipend for the calendar year is $10,000. Students may be enrolled for a degree in either oceanography or meteorology. For further information or applications, please write:

Dr. James J. O'Brien
NASA Traineeship Program
Meteorology Annex
The Florida State University
Tallahassee, Florida 32306
(904) 644-4581

SERVICES, SUPPLIES, COURSES, AND ANNOUNCEMENTS

The Engineering and Groundwater Committee of the Society of Exploration Geophysicists is sponsoring a session at the Fall 1984 S.E.G. Annual Meeting on 'Archaeology and Geophysics'. The session is intended to include technical papers on the application of remote sensing and high-resolution ground geophysical methods in mapping and evaluating human cultural resources. A 1,000–2,000 word extended abstract will be required by May 1, 1984 by those interested in participating. Additional information is available from:

Jeff Wynn, USGS
913 National Center
Reston, Virginia 22092,
telephone: (703) 860-6564

Meetings

Meeting Report

History at 1983 IUGG Meeting

Perhaps because the 1983 IUGG meeting at Hamburg commemorated the 100th anniversary of the First International Polar Year, the 50th anniversary of the Second International Polar Year, and the 25th anniversary of the International Geophysical Year, it was a particularly appropriate forum for the study of the history of space science. By any measure, however, the 18th IUGG Assembly marks a watershed in the study of history and its application to space physics and geophysics.

Besides two highly successful sessions on historical events and on the use of historical records in research sponsored by the IAGA Interdivisional Commission on History, several of the IUGG Union lectures and inter-union sessions specifically addressed historical concerns. In particular, M. Nicolet's address ("Reflexions sur l'Année Géophysique Internationale") and the opening remarks, which reminded the participants of the 1912 meeting in Hamburg of the Association Géodésique Internationale, revolved about historical events.

The excellent exhibit on the life of Alfred Wegener, the "father" of continental drift, set the theme and generally high standards of the historical papers. The high point of the conference, however, for those interested in history was the excursion on August 20–21 to Göttingen and its environs—the location of Gauss's most famous geophysical discoveries.

It had been evident for the last 5 to 8 years that interest in the historical events surrounding the growth of space science and geophysics and of the use of historical records was growing in the IUGG/IAGA community. Based on this interest, IAGA sponsored two sessions specifically devoted to the history of space physics and geophysics (chaired by W. Schröder) and the use of historical records in research (chaired by J. Feynman). Several papers stand out in both sessions.

For example, Barraclough and his colleagues' papers on the use of historical magnetic observations in studying the earth's core and of Halley's Atlantic magnetic surveys indicate the existence of extremely valuable scientific records on the state of the magnetic field for several hundred years in the past. J. Feynman and P. Fougere demonstrated the existence of a sharply defined, 88-year periodicity in solar-terrestrial phenomena.

In the historical events session, typical examples of the quality of the papers were the detailed review by K. Bretterbauer of the roles that J. Payer, C. Weyprecht, and H. Wilczek played in the founding of international polar studies. W. Dieminger discussed the extensive activities in ionospheric physics in Germany prior to and during the Second World War. It should be noted that more than 30 to 40 persons were in attendance at every presentation and for the business meeting.

Several other IUGG and IAGA sessions had papers devoted to historical issues. W. Olson gave a synopsis of the history of studies of the ionospheric and magnetospheric fields in his session on the separation of the observed magnetic field into main, ionospheric, and magnetospheric contributions. At the inter-union symposium on geophysics of the polar regions, C. D. Garland's introductory remarks and historical perspective and G.E.R. Deacon's review of oceanography and the polar years contained several fine references to the historical events associated with various fields. Also of interest were the IASPEI sessions on historical seismograms, another area where long-term historical records are proving to be of great value.

The 2-day trip to Göttingen included a visit to the Physikalisches Institut, where numerous early geophysical instruments of historical importance were exhibited for the tour, and the Institut für Geophysik, where historical seismological instruments were still in active operation.

In the private sector. The annual review of research activities in this program draws more than 100 participants interested in the multidisciplinary, thematic discussions of ongoing research in space-related aspects of geodesy, plate and polar motion, tectonics, body physics, and geopotential fields.

It was suggested, notably by the AGU sections on Geodesy and Tectonophysics, that the review, which is carried out essentially in the format of a scientific meeting, might be of interest to the general membership of AGU. At the same time, combining the review with AGU's annual Spring Meeting would save participants, most of whom are members of the Union, valuable travel money and even more valuable time.

For these reasons, it has been agreed to formulate geodynamics as a separate theme at the 1983 AGU Spring Meeting in Cincinnati. Sessions will be organized by a special chairman selected by the pertinent Section presidents. Contributions will be solicited for presentation in these theme sessions in the 1983 Spring Meeting call for papers, which appears in this issue. These contributions will involve interim and final results of research in the areas mentioned above, descriptions of proposed and completed measurement campaigns, as well as discussions of development of pertinent instruments and spacecraft systems.

This meeting report was prepared by Henry B. Garrett, who is with the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109

Announcements

Geodynamics at AGU Spring Meeting

The NASA Geodynamics Program, incorporating the Crustal Dynamics Project, is being carried out in cooperation with several federal agencies and with participation by many researchers at universities, in government and non-government institutions, and

Watershed Models at Fall Meeting

The Soil Water Committee of AGU's Hydrology Section will sponsor a session on evapotranspiration, soil moisture evolution, and aquifer recharge in watershed models, at the 1983 AGU Fall Meeting. The session will explore the manner in which the hydrologic phenomena of evapotranspiration, soil moisture evolution (including interflow), aquifer recharge and aquifer return flows are treated in current (small) watershed and/or river basin models. More information can be obtained from H. J. Morel-Seytoux, Dept. of Civil Engineering, Colorado State University, Fort Collins, CO 80523 (telephone 303-491-5448 or 491-8549).

Urban Hydrology

The 11th International Symposium on Urban Hydrology, Hydraulics, and Sediment Control will be held at the University of Kentucky in Lexington, Ky., July 23–26, 1984. The deadline for submitting abstracts is December 31.

Abstracts of 400 words or less on the following subjects are invited: hydraulic infrastructures design, analysis, and upgrading; urban water supply and distribution systems; the urban flood plain; social, legal, financial, and economic aspects; and urban stormwater quantity and quality. Abstracts for mini-courses (approximately 4 hours long) are also encouraged.

For more information, write Elizabeth Haden, Coordinator, Office of Continuing Education/Engineering, 223 Transportation Research Bldg., Univ. of Kentucky, Lexington, KY 40506–0043 (telephone: 606-257-3972).

Ice and Bacteria

The Second American Conference on Ice Nucleating Bacteria will be held June 6–9, 1984, at Northern Arizona University in Flagstaff, Ariz. Proceedings of the conference will be pre-printed and distributed at the meeting. The deadline for submitting abstracts is January 1, 1984.

The conference will focus on current investigations and will include both poster sessions and oral presentations on such topics as microbiology, genetics, biochemistry, plant pathology, atmospheric work, and other aspects of the problem of ice nucleating bacteria. Also scheduled is a field trip to the Grand Canyon.

Suggestions for the conference are welcome, including recommendations of individuals who should be included in the program. Representatives of technical firms are welcome if they are willing to exchange information openly. For more information, write: Second American Conference on Ice Nucleating Bacteria, The Ralph M. Bilby Research Center, Box 6013, Northern Arizona University, Flagstaff, AZ 86011.

Longitude Zero

"Longitude Zero," an international symposium to commemorate the 100th anniversary of the adoption of Greenwich as the location of the prime meridian, will take place at the National Maritime Museum in Greenwich, UK, July 9–13, 1984. Historians of astronomy are invited to discuss all aspects of the prime meridian, including navigation, time-keeping, geodesy, astronomy, and the problems of the international administration of science.

Planned meeting topics include longitude and meridians before the 17th century, 19th century meridians and the adoption of Greenwich, the geodetic aspect, the development of observatories during the 19th century, international cooperation, the French claim, the influence of instrumentation on the development of science, and "toward Universal Time." A visit to the Royal Greenwich Observatory and a general session on the history of astronomy also are planned.

The symposium is held under the auspices of the International Union for the History and Philosophy of Science and the International Astronomical Union. For more information, contact the conference officer, "Longitude Zero" Symposium, National Maritime Museum, Greenwich, London SE0 9NF, UK.

Correction

The report of AGU's Spring Meeting activities (*Eos*, July 19, 1983, p. 464) incorrectly listed paper SA51–05 as undelivered at the meeting. The paper, "Concentrations of Mg and Fe Near 92 Km" by W. Swider, was delivered earlier in the meeting than originally scheduled.

Geophysical Year

New Listings

A boldface meeting title indicates sponsorship or cosponsorship by AGU.

January 10–11, 1984 Computer Applications in Mineral Exploration, Toronto, Canada. Sponsors, Toronto Geological Discussion Group, Geological Assoc. of Canada, Canadian Institute of Mining and Metallurgy, Canadian Exploration Geophysical Soc., and Assoc. of Exploration Geochemists. (The Organizing Committee, CAME 1984, c/o Samim Canada Ltd., Suite 2116, 130 Adelaide St. W., Toronto, Canada M5H 3P5).

April 2–4, 1984 Second National Symposium and Exposition on Groundwater Instrumentation, Las Vegas, Nev. Sponsor, National Well Water Assoc. (NWWA). (D. M. Nielsen, Conference Coordinator, NWWA, 500 W. Wilson Bridge Rd., Worthington, OH 43085; tel.: 614-846-9355).

June 4–7, 1984 Symposium on Climate and Paleoclimate of Lakes, Rivers, and Glaciers, Igls, Austria. Sponsor, International Commission on Climate, IAMAP. (M. Kuhn, Institut fuer Meteorologie und Geophysik, Schoepfstrasse 41, A-6020 Innsbruck, Austria.)

June 4–8, 1984 International Water Resources Association (IWRA) Seminar on River Basin Strategy, Linköping, Sweden. (U. Lohm, Water Theme, Linköping Univ., S-58183, Linköping, Sweden.)

June 6–9, 1984 Second American Conference on Ice Nucleating Bacteria, Flagstaff, Ariz. (The Ralph M. Bilby Research Center, Box 6013, Northern Arizona Univ., Flagstaff, AZ 86011).

July 9–13, 1984 Longitude Zero, Greenwich, England. Sponsors, International Union for the History and Philosophy of Science and the International Astronomical Union. (Conference Officer, "Longitude Zero" Symposium, National Maritime Museum, Greenwich, London SE0 9NF, England).

July 23–26, 1984 11th International Symposium on Urban Hydrology, Hydraulics, and Sediment Control, Lexington, Ky. Sponsor, University of Kentucky. (E. Haden, Coordinator, Office of Continuing Education/Engineering, 223 Transportation Research Bldg., Univ. of Kentucky, Lexington, KY 40506–0043; tel.: 606-257-3972).

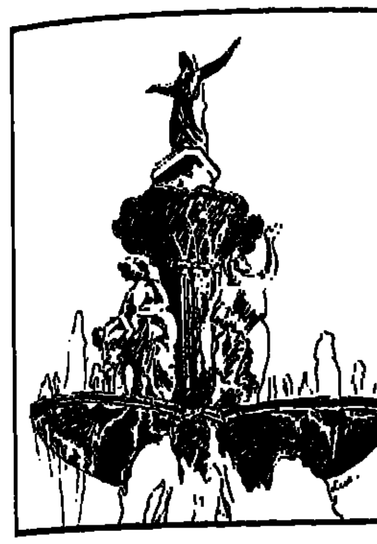
July 29–August 4, 1984 Europrobe/physics Assembly, Louvain-la-Neuve, Belgium. Sponsor, European Geophysical Society. (G. M. Brown, Dept. of Physics, Univ. College of Wales, Aberystwyth, Wales, UK.)

July 31–August 2, 1984 Fourth International Symposium on Stochastic Hydraulics, Univ. of Illinois at Urbana-Champaign. Sponsor, International Association for Hydraulic Research. (B. C. Yen, W. H. Tang or G. E. Stout, Dept. of Engineering, Univ. of Illinois, 208 N. Romine St., Urbana, IL 61801; tel.: 217-333-0687 or 217-333-0536.)

August 13–17, 1984 12th International Laser Radar Conference, Aix-en-Provence, France. Sponsors, IAMAP and American Meteorological Soc. (G. Megie or J. P. Granier, Service D'Aéronomie du CNRS, 12th International Laser Radar Conference, BP 3, 91370-Verrières le Buisson, France).

Change

March 19–23, 1984 Fifth Northern Research Basins Symposium and Workshop, Vierumäki, Finland. (Charles Slaughter, Chairman, U.S. Working Group, Institute of Northern Forestry, USDA Forest Service, 308 Tanana St., Fairbanks, AK 99701, or Olli Pusanen, Secretary, Organizing Committee, Hydrological Office, Box 436, 00101 Helsinki 10, Finland.) *New U.S. contact shown.*



Spring Meeting: Call for Papers

Abstracts must be received at AGU by 5 P.M. on February 22 to be on time. Late abstracts (1) may be summarily rejected by program chairman, (2) may not be published in advance of the meeting, and (3), if accepted, will be charged a $25 late fee in addition to the regular publication charge.

The 1984 Spring Meeting of the American Geophysical Union will be held in Cincinnati, May 14–18, at the Cincinnati Convention Exposition Center. Blocks of sleeping rooms are being held at the Clarion (formerly Stouffer's) and Netherlands hotels for those attending. Corresponding authors will be sent housing and registration forms. In addition, the forms will be published in *Eos*.

General Regulations

• Abstracts may be rejected without consideration of their content if they are not received by the deadline or are not in the proper format. Abstracts may also be rejected if they contain material outside the scope of AGU activities or if they contain material already published or presented elsewhere.

Only **one contributed paper by the same first author will be considered for presentation;** additional papers (unless invited) will be rejected automatically.

• Only AGU members may submit an abstract. The abstract of a nonmember must be accompanied by a membership application form (with payment) or it must be sponsored by an AGU member.

• There is a publication charge of $40 ($30 if prepaid) for each abstract. The publication charge is $20 if the first author is a student. Both invited and contributed papers are subject to the publication charge. Prepayment of the publication charge can save money. Send a check for $30 ($15 for students) with your abstract. The abstract must be received at AGU by February 22 to avoid an additional $25 charge. Abstracts not prepaid will be invoiced prior to the meeting. Payments will be accepted at the meeting.

• AGU will acknowledge receipt of all abstracts. Notification of acceptance and scheduling information will be mailed to corresponding authors in late March.

Abstracts

The abstract page is divided into two parts: the abstract itself and the submittal information. Follow the instructions for both carefully. Please use a carbon ribbon to type the material, and do not exceed the maximum dimensions (11.8 cm x 18 cm) of the abstract. **Abstracts that exceed the noted size limitations will be trimmed to conform.**

The meeting program will be prepared by photographing the abstracts exactly as they are received. Use the model abstract to prepare the final version. Submission of an abstract for an AGU meeting is presumed to carry with it permission for AGU to reproduce the abstract in all editions of *Eos* and in the programs and reports relating to the meeting. It is also presumed to permit the free copying of those abstracts. Although *Eos* is a copyrighted journal, authors are not requested to transfer copyright. Copyright, where it exists, will be reserved by the authors.

Submittal Information

Numbers refer to the items in the submittal block on the sample abstract.

1. Title of meeting.
2. Identification (only members may submit an abstract; this includes invited authors): Type the identification number of one member author (ID number is the line consisting of four letters followed by the six digits; see member's mailing label on *Eos* or journals), or if no author is an AGU member, type the ID number of the member sponsor (sponsor's name must also appear on the abstract at the end of the author portion). If no ID number is given, a membership application and dues payment must accompany the abstract. Call AGU immediately at 202-462-6903 if you need an application.
3. Corresponding address: Give complete address and phone number of author to whom all correspondence (acknowledgment and acceptance letters) should be sent. Abbreviate as much as possible.
4. Section (or theme) to which abstract is submitted (use the following letter abbreviations): A (Atmospheric Sciences); G (Geodesy); GD (Geodynamics); GP (Geomagnetism and Paleomagnetism); H (Hydrology); O (Ocean Sciences); P (Planetology); S (Seismology); SA (Aeronomy); SM (Magnetospheric Physics); SC (Cosmic Rays); SS (Solar and Interplanetary Physics); T (Tectonophysics); V (Volcanology, Geochemistry, and Petrology); U (Union); Mineral Physics (submit to T or V, as appropriate, noting mineral physics as special session).
5. Type title of special session (if any) to which submittal is made.
6. Indicate your preference for a particular kind of presentation by one of the following letters: O, oral; P, poster; T, title. The chairman may assign you to one of these types of presentation in order to fit his program plan.
7. Percent of material previously presented or published, and where.
8. Billing information.
(*a*) Complete billing address if other than the corresponding address (item 3 above).
(*b*) If purchase order is to be issued, indicate number upon submittal of abstract. Invoices returned to AGU because of insufficient billing information will be assessed an additional charge of $10.
(*c*) If a student member is the first author, the student publication rate is applicable. Type "student rate applicable."
(*d*) If prepaid, enter amount enclosed.
9. Indicate whether paper is C (contributed) or I (invited). If invited, list name of inviter.

Poster Sessions

A large, centrally located meeting room will be set up for poster presentations. Experience from AGU meetings and from other scientific societies has shown that a poster presentation, while more demanding of the author, can provide a superb opportunity for comprehensive discussions of research results. Some sections are organizing poster sessions on specific topics, and contributed papers on these subjects will automatically be scheduled as posters. In other sections it may be necessary to assign papers to poster sessions even though their authors requested oral presentation.

Presenters of poster papers are reminded that a poster exhibit requires careful preparation. Figures and text should be scrutinized in detail, and authors must be prepared to discuss the contents of their papers in depth. Under these conditions, well-prepared figures and concise, logical text are essential.

Program Committee

Meeting Chairman and Union (U) H. Frank Eden, NSF
Atmospheric Sciences (A) Ronald Lavoie, NOAA
Geodesy (G) Demos Christodoulidis, NASA/GSFC
Geodynamics (GD) Louis S. Walters, NASA Hq.
Geomagnetism and Paleomagnetism (GP) Patrick Taylor, NASA/GSFC
Hydrology (H) John R. Ritter, USGS, Harrisburg, Pa.
Ocean Sciences (O) Robert L. Molinari, AOML/NOAA
Planetology (P) Carle M. Pieters, Brown University
Seismology (S) Emile Okal, Yale University
SPR: Aeronomy (SA) Raymond G. Roble, NCAR
SPR: Cosmic Rays and Solar and Interplanetary Physics (SC/SS) Miriam A. Forman, SUNY, Stony Brook (SC); Bruce T. Tsurutani, Jet Propulsion Laboratory (SS)
SPR: Magnetospheric Physics (SM) Michael Schulz, Aerospace Corp.
Tectonophysics (T) Mark Parmentier, Brown University
Volcanology, Geochemistry, and Petrology (V) Peter W. Lipman, USGS, Denver

Special Sessions

Atmospheric Sciences

Acid Precipitation
Meteorology and Atmospheric Chemistry of the Polar Regions

Geomagnetism and Paleomagnetism (GP)

Rock Magnetism
Geomagnetic Methods Applied to Economic Resources
Magnetic Anomaly Studies and the Structure of the Sea Floor
Magnetic Polarity Stratigraphy and Time Scales
Irregularities in the Secular Variations and Geodynamic Implications (G)

Hydrology (H)

Symposium on Miscible and Immiscible Transport in Groundwater
Symposium on Field Methods for Supporting Groundwater Chemical Transport Models
Measurement of Groundwater Transport Parameters

Ocean Sciences (O)

El Niño: Biology and Chemistry
El Niño: Physical Characteristics
Gulf Stream Dynamics
Ocean Technology
Response of the Upper to Very Strong Winds
Inland Seas
Oceanography of Straits and Sills
Oceanic Sources of Atmospheric Trace Gases
Oceans Monitoring
Oceanographic Applications of EM Fields

SPR: Cosmic Rays (SC)

New Techniques and Applications of Geomagnetic Effect in Cosmic Rays Studies

SPR: Magnetospheric Physics (SM)

Aurora and Substorms (Poster Session)
Geomagnetic Pulsations
Ionosphere and Plasmasphere
Geomagnetic Tail and Boundary Layer (Poster Session)
Magnetospheric Currents and Electric Fields (Poster Session)
Numerical Simulation of Space Plasmas (Poster Session)
Waves, Instabilities, and Turbulence in Space Plasmas (Poster Session)

Other Themes

Geodynamics

Primarily designed as the annual review of the research activities of the NASA Geodynamics Program, the geodynamics sessions will also incorporate appropriate contributed papers of a multidisciplinary nature in areas such as space-related aspects of geodesy, plate tectonics and polar motion, tectonics, body physics, and geopotential fields. All sessions in geodynamics will be sponsored by the Geodesy and/or Tectonophysics sections.

Mineral Physics

If one of the following fields is covered in the broadest sense, regardless of the section to which your paper is submitted, please add on your abstract, under number 5 of the submittal information, the phrase "For Mineral Physics Session," and one of the following fields: (1) physical measurements on minerals, (2) calorimetry, (3) high-pressure mineralogy, (4) defect structure studies, (5) mineral and solids equations of state, (6) quantum mechanics of solids, (7) spectral mineralogy, or (8) electrical measurements on minerals

Sample Abstract

11.8 cm

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Technique for the Preparation of Abstracts

F. R. S. T. AUTHOR (School of Oceanography,
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Abstract Deadline: February 22, 1984

Mail original and two copies to:

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AGU

K. C. Yeh: Radio Science Editor

Advances in satellite technology and computer science have had the greatest impact on radio science in the last quarter century, according to Kung Chie Yeh, the new editor of *Radio Science*. Yeh, whose term began July 1 (*Eos*, April 12, 1983, p. 137, February 22, 1983, p. 73), is a professor in the electrical engineering department at the University of Illinois at Urbana-Champaign.

An international authority on ionospheric radio physics, Yeh also is known for his work on trans-ionospheric radio wave propagation as it affects earth-space communications and satellite navigation. He has been studying radio science for nearly 30 years.

Today, the biggest problem facing radio scientists, said Yeh in a recent interview with *Eos*, is that the region of scientific interest is "so vast that, even with current computer capabilities and the satellite sensing capabilities, it is not possible at the moment to foresee that we could sample the geophysical parameters with enough density and enough continuity in time." Yeh added that he thinks such breadth of sampling probably will not be possible for at least two decades.

Yeh said he does not anticipate any drastic changes in *Radio Science*, although he hopes to broaden the scope of the journal by including papers in new areas of the science. "We're always open for good contributions," he said.

Soon to be published in the journal are two special collections of papers: "Radio Probing of the High Latitude Ionosphere and Atmosphere" and "Multiple Parameter Radar Measurements of Precipitation." In addition, two special collections are being assembled, Yeh said. They are "Emissions From Particle Beams in Space" and "Beacon Satellite Studies of the Earth's Environment." Another special collection, proposed by immediate past *Radio Science* editor Akira Ishimaru, will be a sampling of papers from the recent URSI symposium held in Spain on electromagnetic theory.

The University of Illinois granted Yeh a B.S. degree in electrical engineering in 1953; 1 year later, he earned his M.S.E.E. from Stanford University. From 1954 to 1958 Yeh was a research assistant at Stanford, working on propagation problems in what was then the Radio Propagation Laboratory (later renamed the Radioscience Laboratory and recently renamed again the Space, Telecommunications, and Radioscience Laboratory).

In 1958, after receiving his Ph.D. from Stanford, he joined the electrical engineering department at the University of Illinois at Urbana-Champaign. For 6 months in 1966 and again in 1976 he was a visiting professor at the electrical engineering department at the National Taiwan University in Taipei. In 1967 he was a visiting fellow for 1 month at the electrical engineering department at the University of Hawaii in Honolulu. Yeh was elected an associate of the University of Illinois' Center for Advanced Study during the 1973–1974 academic year. In 1977 he was invited by the Space Research Center of the Polish Academy of Sciences to deliver a sequence of lectures on motions in the ionosphere.

Yeh was an associate editor of *Radio Science* from 1979 to 1981, and served as co-guest editor of the special issue "Radar Investigations of the Clear Air" in 1980. A member of the Solar-Planetary Relationships section, Yeh joined AGU in 1960.

Questions about the journal, comments, suggestions, and papers should be sent to K. C. Yeh, Editor, *Radio Science*, University of Illinois, 1406 West Green St., Urbana, IL 61801-2991. Yeh's term as editor ends December 1986.—*BTR*

Section Candidates

Eos is carrying biographies and photographs of all candidates for President-elect, General Secretary, and Foreign Secretary of the Union and for President-elect and Secretary of each Section. In addition, statements by the candidates for Union offices and for Section President-elect will appear. The sections and the date of the issue in which their material appeared are as follows:

Geodesy; Geomagnetism and Paleomagnetism August 30
Planetology and Planetology petition candidate August 30 and October 18
Atmospheric Sciences September 27
Tectonophysics October 11
Seismology October 18
Hydrology October 25
Ocean Sciences November 1
Volcanology, Geochemistry, and Petrology November 8

The slate of candidates for all offices was carried in the June 21 issue.

Solar-Planetary Relationships: President-elect

Robert A. Helliwell A fellow of AGU since 1967; 63 years old. Professor of Electrical Engineering, Stanford University. Major interests: wave propagation and controlled VLF wave-particle interactions in the ionosphere and magnetosphere. B.S. (1942) and M.S. (1943) in electrical engineering, Stanford; Ph.D. in electrical engineering, Stanford, 1948. Stanford faculty since 1946. Fellow: AGU, AAAS, IEEE; member: NAS, Sigma Xi, Tau Beta Pi, Phi Beta Kappa; member of Advisory Board, Planetary and Space Science Journal; Acting Director, Center for Space Sciences and Astrophysics, Stanford University; 89 publications, 52 published by AGU. Author, monograph *Whistlers and Related Ionospheric Phenomena*. Served on Executive Committee, Polar Research Board of the National Academy of Sciences; past president, International Commission IV, International Scientific Radio Union (URSI); past chairman, Committee on Space Physics, Space Science Board of the National Academy of Sciences; Delegate-at-large, Commission H, URSI. Recipient: Antarctic Service Medal, National Academy of Sciences, 1965; Appleton Prize, The Royal Society of London, 1972.

Statement

"My objective is to maintain the present vigor of the AGU section on Solar-Planetary Relationships and, if possible, to increase the level of intellectual exchange that takes place at the regular meetings of AGU. I would like to find solutions to some of the chronic problems of the annual meetings, including the overlap of similar sessions. I am also interested in the debate about poster sessions versus regular sessions. I would like to explore the possibility that the advantages of both could be retained by some kind of combined presentation. For example, it might be possible to relate a poster session to a particular oral session through the use of selected chairmen. Another idea would be to consider limiting the number of slides that could be presented in the regular session so as to encourage the use of poster sessions for more detailed presentations and discussion.

"I would also like to explore the possibility of bringing session chairmen earlier into the session planning process. Now the Chair is separate from the planning of the session, and hence has little input regarding the content and management of the session. If the Chairs were to assist in the selection of papers, they could then be expected to contribute more fully to the discussions following each paper. They would also be in a better position to anticipate discussions for which extra time could be allowed. Now when an interesting or controversial question arises, it is often necessary for the Chairman to shut off debate at the critical point in order to keep the session on schedule. Since a primary purpose of the AGU meetings is to enhance our understanding of ongoing research, it is essential that critical discussion not only be permitted but encouraged."

Martin Walt A member of AGU since 1961; 57 years old. Present position is Director of Physical Sciences at the Lockheed Palo Alto Research Laboratory. Areas of scientific interest include most areas of Space Plasma Physics, with particular emphasis on the diffusion of charged particles in radiation belts and aurora. B.S., California Institute of Technology, 1950; M.S., University of Wisconsin, 1951; Ph.D., University of Wisconsin, 1953. Staff member, Los Alamos Scientific Laboratory 1953–1956. Lockheed Palo Alto Research Laboratory 1956 to present. Has published 84 scientific papers, 20 in AGU journals. Edited one book on auroral phenomena. Fellow of AGU and the American Physical Society and a member of AIAA. Wisconsin Research Fellow 1950–1951, AEC Fellow 1951–1953. Member of Organizing Committees for annual Advanced Study Institutes in Space Physics 1965–1976. Vice-Chairman of Gordon Research Conference on Space Plasma Physics 1979, Chairman in 1981. Member of the Advisory Committee for University of California Space Science Laboratory 1971–1977. Member Scientific and Educational Advisory Committee for Lawrence Berkeley Laboratory 1983-present. Member NASA Management Operations Working Group on Solar Terrestrial Physics, 1977–1982. Served on various NSF, NAS/NRC, and DoD study panels. AGU activities are the following: Secretary Fall Annual meeting 1971 and 1972, General Program Chairman Fall Meeting 1973–1975. Member AGU Publications Committee 1978–1982; Chairman of Journals Board 1978–1980. AGU Meetings General Chairman 1979–1982; currently a member of the Committee on History of Geophysics and a member of the Subcommittee on Electronic Transmission of Publishable Data.

Statement

"The principal goals of AGU are to promote research in geophysics and to make the results of this research widely available. To achieve these goals the Union sponsors scientific meetings and publishes a series of journals. The Union also conducts activities for the professional benefit of its members such as employment services and provides information via *Eos* on the current events affecting our profession.

"In the coming years AGU must make difficult decisions in all these areas. In publications, the technology of editing, composing, and transmitting information is developing rapidly and will affect the traditional way professional societies publish their journals. While it is not at all obvious how AGU should respond to this new technology, we should keep abreast of the developments, monitor programs of our sister societies, and be prepared to move as required. I strongly support the current efforts of the Publications Committee to study this evolving field and to recommend prudent steps to avoid the need for any sudden changes in our publication programs.

"In the meetings area the West Coast meeting has become inconveniently large for the presently used facilities. In the near term I favor the organization of more topical conferences and the continued use of poster sessions. Some of the strain on the West Coast meeting can also be relieved by encouraging more attendance at the Spring Meeting. In the long term, if growth continues, it may be necessary to (a) use a larger meeting facility in San Francisco, (b) schedule the various sections of the Union to meet in sequence over a two week period, or (c) move to another city. At present I prefer a, b, and c in that order, but will wish to hear the recommendations of the Meetings Committee on this matter.

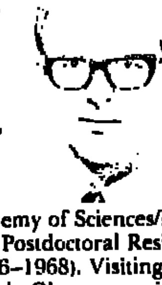
"As the leading professional society in the field of Solar-Planetary Relationships, AGU should take the lead in making the public and various branches of government aware of the needs, the significance, and the opportunities in our discipline. I believe such actions are a proper activity for AGU. However, I strongly oppose suggestions that AGU take stands on political issues which do not have a direct bearing on the primary goals of AGU."

Solar-Planetary Relationships: Secretary–Aeronomy

Gulamabas G. Sivjee A member of AGU since 1972; 45 years old. Professor of Physics and Head of Physics Department, University of Alaska, Fairbanks. Major interests: Atomic and molecular processes in the atmosphere; magnetosphere-ionosphere interaction. B.Sc. in Physics, University of London, 1963; Ph.D. in Physics, Johns Hopkins University, 1970. Post-Doctoral Fellow, Institute of Space and Atmospheric Studies, University of Saskatchewan, 1971–1972; Geophysical Institute, University of Alaska since 1972; Head, Graduate Program in Space Physics and Atmospheric Science, 1980–1982; Program Director for Aeronomy, NSF, 1982–1983; 35 refereed publications, 17 published by AGU. British Petroleum Academic Achievement Award, 1962, 1983; British Commonwealth Fellowship, 1965; Rockefeller Foundation Fellowship, 1966–1970.

Edward P. Szuszczewicz A Member of AGU since 1973; 42 years old. Head, Space Plasma Diagnostics Group, E. O. Hulburt Center for Space Research, Naval Research Laboratory. Major interests: Experimental space plasma physics, geoplasma instabilities, ionospheric irregularity distributions, active experiments in space, laboratory simulations of space-plasma processes. B.S. in Physics, St. Joseph's University 1963, Ph.D. in Experimental Plasma Physics, St. Louis University 1969. Alexander von Humboldt Scientist, Physikalisches Institut, Universitaet Wuerzburg, Germany, 1969–1970; NRC Research Associate, NASA/GSFC, 1970–1972; Research Physicist, NRL Aeronomy Section, 1972–1975; Head, NRL Aeronomy Section, 1975–1981; Visiting Scientist, UCLA, Experimental Plasma Physics Group, 1981; Head, NRL Space Plasma Diagnostics Group, 1981-present. Memberships: URSI Commission III WG 5 (1974–1976); IMS Working Group for ICAS (1976); NASA/NSF Steering Committee for Solar-Terrestrial Physics Workshop (1982–1983); co-chairman NASA/NSF STPW Working Group on High-Latitude Ionospheric Irregularity Structures, 1982–1983; 49 publications, 12 published by AGU. Current activities include: global definition of ionospheric F-region irregularity distributions and causal mechanisms; energetic-electron-beam experiments for fundamental studies of beam-plasma interactions and simulation of high-latitude phenomena; chemical release experiments for studies of fundamental plasma expansion processes and simulations of remote solar-terrestrial phenomena including polar wind expansion; principal investigator on the S3-4 satellite investigation of *F*-region irregularities; co-investigator on the NASA/Shuttle Beam-Plasma-Physics team, principal investigator on LASSII/CRRES "in situ" plasma experiment for measurement of low-earth-orbit irregularities and chemical-injection phenomena; principal investigator on NASA study of ionospheric effects on Shuttle-borne imaging radar (SIR-B).

Solar-Planetary Relationships: Secretary–Cosmic Rays



Leonard F. Burlaga A member of AGU since 1966; 45 years old. Physicist. B.S., University of Chicago, 1960; M.S., University of Minnesota, 1962; Ph.D., University of Minnesota, 1966. Employed at NASA/Goddard Space Center since 1966, initially as a National Academy of Sciences/National Research Council Postdoctoral Resident Research Associate (1966–1968). Visiting Scientist at the High Altitude Observatory in Colorado and at the Laboratorio Plasma Spazio in Italy. Research interests include cosmic rays, interplanetary magnetic fields and plasmas, magnetohydrodynamics, interaction of the solar wind with planets and comets, and magnetospheric physics. Co-investigator on several satellite experiments, including experiments on Voyager 1 and 2, Helios 1 and 2, and Explorers 34, 41 and 43. OPEN Deputy Project Scientist. Author of more than 85 scientific papers. Recipient, NASA Exceptional Scientific Achievement Medal, 1979. Committee memberships include Solar and Heliospheric Physics Management Operations Working Group; Interplanetary Physics Working Group; Comet Science Working Groups; and Working Groups for OPEN, Plasma Turbulence Explorer, Solar Corona Explorer, and the Solar Cycle and Dynamics Mission. Chairman, Division IV (Solar Wind and Interplanetary Magnetic Field) of the International Association of Geomagnetism and Aeronomy (1979–1983). Member, AGU, American Physical Society, and International Astrophysical Union.

Douglas C. Hamilton A member of AGU since 1975; 35 years old. Currently a Senior Research Associate in the Space Physics Group, Department of Physics and Astronomy, University of Maryland. B.A., University of Kansas, 1969; M.S. (1971) and Ph.D. (1977) in physics, University of Chicago. Spent a year as a research associate at the University of Chicago before going to the University of Maryland in 1978. Areas of scientific interest include the origin and acceleration of energetic particles in the magnetospheres of earth, Jupiter, and Saturn, the composition of solar cosmic rays, the propagation and acceleration of energetic particles in interplanetary space, and instrumentation development for the detection of charged particles in space. Author or coauthor of 18 scientific papers, 7 of which were published in AGU journals, and presenter of 11 talks at AGU meetings. A member of AGU and the American Physical Society.

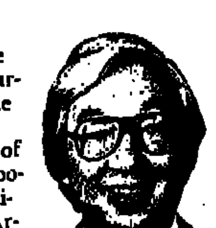
Solar-Planetary Relationships: Secretary–Magnetospheric Physics

Mary K. Hudson A member of AGU since 1972; 34 years old. Associate Research Physicist and Senior Fellow, Space Sciences Laboratory, University of California, Berkeley. Major interests: space plasma theory, auroral particle acceleration, plasma simulations. B.S. in Physics, UCLA, 1969. Member Associate Staff, The Aerospace Corporation, 1969–1971. M.S. in Physics, UCLA, 1971; Ph.D. in Physics, UCLA, 1974. With Space Sciences Laboratory, University of California, Berkeley since 1974. Member: AGU, APS; Woodrow Wilson Fellow, NDEA IV Fellow, Phi Beta Kappa, Regents Scholar. Served on Committee on Solar and Space Physics, 1976–1979 (NAS-NRC) and presently a member of OPEN Science Working Term (NASA). About 34 publications, 24 published by AGU. Currently Associate Editor, JGR-Space Physics.

George K. Parks A member of AGU since 1964. BA and Ph.D. in physics from the University of California, Berkeley, in 1961 and 1966 respectively. Spent 3 years as a post-doctoral research associate in the School of Physics and Astronomy, University of Minnesota, Minneapolis, and 2 years as professeur associé at the Faculté des Sciences, Université de Toulouse, Toulouse, France, before he joined the faculty at the University of Washington, Seattle. Currently professor of geophysics and holds adjunct professorships in the Atmospheric Sciences and Physics departments. Research interests include experimental and theoretical studies of space plasma phenomena. Conducted ballon-borne and spacecraft experiments since 1964 to study auroral, magnetospheric, and interplanetary space plasma phenomena. Most recent research endeavors include looking for energetic X rays from thunderstorm and lightning active regions.

Solar-Planetary Relationships: Secretary–Solar and Interplanetary Physics

Alan J. Lazarus A member of AGU since 1960; 52 years old. Senior Research Scientist and Academic Officer, Physics Department, MIT, S.B., MIT, 1953; Ph.D., Stanford, 1959; RAND Corporation, 1958–1959; MIT, 1959-present. NASA Hq., High Energy Astrophysics, 1974–1975; Associate Dean of Students, MIT, 1977–1980. Main research work: construction of instrumentation for measuring the solar wind and analysis of data therefrom. Principal interests: large scale solar wind structure, interaction of the solar wind with planetary magnetospheres, and the structure of the magnetospheres themselves.



Bruce T. Tsurutani Member of AGU since 1967; 42 years old. Currently a member of the Technical Staff of the Space Physics Section of the Jet Propulsion Laboratory, California Institute of Technology. Areas of scientific interest include: interplanetary physics (heliospheric magnetic field configuration, cosmic ray modulation); collisionless shocks, upstream waves, and particle acceleration; solar wind interaction with magnetospheres (magnetic merging, viscous interaction); plasma physics (instabilities and wave-particle interactions); magnetospheric plasma waves (plasmaspheric hiss, chorus, magnetopause emissions, lion roars); auroral physics (particle precipitation, substorms and storms); and astrophysics (X ray bursters). B.A. and Ph.D. from the University of California at Berkeley. Permanent employee of JPL since graduation from Berkeley in 1972. Also a member of AAAS, Sigma Xi, N.Y. Academy of Sciences, and URSI. 72 publications, half of which have been published in AGU journals. Publications in other journals include: *Science, Nature, Scientific American, Astrophys. J. Letts.* Recent publications include: "Waves Upstream of Interplanetary Shocks" (JGR, in press, 1983), "Energetic Protons Accelerated at Corotating Shocks: Pioneer 10 and 11 Observations From 1 to 6 AU" (JGR, *87*, 7389, 1982), "Lion Roars and Nonoscillatory Drift Mirror Waves in the Magnetosheath" (JGR, *87*, 6060, 1982), "Diffusion Processes in the Magnetopause Boundary Layer" (GRL, *9*, 1247, 1982), and "Observations of the Interplanetary Sector Structure up to Heliographic Latitudes of 16°: Pioneer 11" (JGR, *83*, 717, 1978). Current Secretary of SPR: Solar and Interplanetary Physics. As Secretary, has organized or is organizing 10 Special Sessions of AGU. A member of the AGU Journals Board since 1981. Currently leading the revision of the AGU indices and the merging of the indices with the Am. Inst. of Phys. PAC System. Currently a Co-investigator on the ISEE-3 and ISPM Magnetic Field Investigations, MS-T5 Plasma Wave Investigation and the EXOS-D Ultraviolet Experiment. Co-organized an ISEE Upstream Wave and Particle Workshop and a special issue of JGR (*86*, 4319, 1981). Presently participating in the organization of an AGU Chapman Conference on Collisionless Shocks (Napa Valley, Feb. 1984).

SPR Nontechnical Sessions

Two nontechnical events are scheduled for the Solar-Planetary Relationships (SPR) Section during AGU's 1983 Fall Meeting in San Francisco.

The Section business meeting will be held at 5:15 p.m., Wednesday, December 7, in the Emerald Ball Room of the Holiday Inn. One of the agenda items for the business meeting is to determine what the section members wish to do about business meetings and social events in the future.

Later that evening, there will be an SPR social hour (cash bar) followed by dinner at A. Sabella's restaurant on Fisherman's Wharf, beginning at 6:30 p.m. SPR President Marcia Neugebauer reports that this will be a purely social occasion, with no speeches, but perhaps some entertainment (if anyone comes up with any good ideas). The menu will be Insalata Mista (a green salad with Italian-style goodies in it), shrimp risotto, and either chocolate or mint parfait. For those of you who can't or won't eat shrimp, a few entrees of filet of sole will be available. The cost is \$18.50 per person, which includes tax and tip. Some earlier announcements listed the cost of the dinner as \$20.00. If you have paid \$20.00, you will get a \$1.50 refund.

Supporting Members

Individuals

All dues-paid members contributing an additional \$80 or more in any single year earn recognition as Individual Supporting Members for that year. Among the present Individual Supporting Members, there are 16 Life Supporting Members. To have achieved this special recognition, they have contributed \$1500 or more thus far during the AGU-GIFT program. As a benefit (or dividend) they have no further dues obligations.

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John J. Gallagher, Jr., J. Freeman Gilbert, William C. Graustein, Thomas I. Gray, Jr., Edwin T. Green, Richard Groeber, John K. Hall, Sigmund I. Hammet, John W. Handin, Warren W. Hastings, Hugh C. Heard, J. B. Hersey, Kenneth L. Hunkins, David S. Johnson, Albert W. Kaddatz, William W. Kellogg, Carl Kisslinger, John A. Knauss, Max A. Kohler, Serge A. Korff, Dale C. Krause, Irving P. Krick, Joseph W. Lang, Gordon C. Lill, J. Virginia Lincoln, James P. Lodge, Jr.

Alexander Malahoff, Thomas F. Malone, Elwood Maple, William Markowitz, Ronald G. Mason, John C. Maxwell, Vincent E. McKelvey, Gilbert D. Mead, Jaylee M. Mead, Buford K. Meade, Leslie H. Meredith, J. Murray Mitchell, Jr., Christopher N. K. Mooers, Jerome Namias, Worth D. Nowlin, Jr., Amos Nur, Hugh Odishaw, Feodor Ostapoff, Ned A. Ostenso, Ernest J. Parkin, O. Scott Petty, W. H. Pickering, Louis O. Quam, John C. Reed, Joseph L. Reid, Malcolm Rigby, Walter O. Roberts, Eugene C. Robertson, Juan G. Roederer, Claes G. H. Rooth, Morton J. Rubin, William B. F. Ryan.

Michael Schulz, Alan H. Shapley, Joseph V. Smith, Waldo E. Smith, Kenneth C. Spengler, Thomas W. Stern, Edward C. Stone, Glenn E. Stout, Verne E. Suomi, George H. Sutton, Kendall L. Svendsen, Lynn R. Sykes, Manik Talwani, Charles V. Theis, George A. Thompson, M. Nafi Toksöz, Richard P. Turco, John W. Vanderwilt, Pierre Verdeil, James I. Vette, Clyde Wahrhaftig, Martin Walt, Harvey O. Westby, Fred D. White, Loren D. Wicks, Owen W. Williams, Abel Wolman, Oliver R. Wulf, Gordon A. Young, John M. Zeigler.

Organizations

Many organizations show their support of the objectives of AGU through supporting membership in one of the following dues categories (1984 rates):

Sustaining Members	\$2,400
Contributing Members	\$1,200
Supporting Members	\$400

Through their membership in AGU, these organizations also show that they are committed to helping fulfill the geophysics information needs of their staff scientists.

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AGU (cont. on p. 940)

AGU *(cont. from p. 939)*

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Phillips Petroleum Company
Schonstedt Instrument Company
Teledyne/Geotech Division
Texaco, Inc.
TRW, Inc./TRW Systems Group
UCAR
Western Geophysical Company

Membership Applications Received

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary section affiliation.

Motowo Fujiwara (A), B. A. Hausman (SM), N. Ross Hill (S), Donald O. Hodgins (O), Ronald V. James (H), Jeffrey Paul Laible (H), Barney D. Lewis (H), Randall Marrett (T), Paul Janusz Martin (O), Peter R. Marvin (T), Dai C. McClurg (P), R. C. Michael (T), David B. Nash (H), Marcy S. Newton (V), Kazvhito Ozawa (V), Nakaya Shyu.

Student Status

John E. Heidenreich (A), Diane Heinze (H), Jean Housepian (A), Hans W. Jannasch (O), Lee Scott Kelley (T), James Knapp (V), Scott Linneman (V), Anthony R. Lotimer (H), Andres J. Mendez (S), Gregory Murphy (V), Dapei Wang (H).

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GAP

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Aeronomy

0490 Instruments (Total Ozone Measurement)
INTERCOMPARISON OF THE NIMBUS 7 SBUV/TOMS TOTAL OZONE DATA SETS WITH DOBSON AND M83 RESULTS
P. K. Bhartia [illegible]
[illegible]
J. Geophys. Res., Atmos., Paper 3D1668

0499 General (VHF-Radar)
THE MOBILE SOUSY DOPPLER RADAR - TECHNICAL DESIGN AND FIRST RESULTS
P. Czechowsky (Max-Planck-Institut für Aeronomie, 3411 Katlenburg-Lindau, FRG) [illegible]
[illegible]
Rad. Sci., Paper 3S1714

Electromagnetics

0703 Antennas
RADIATION OF ION ACOUSTIC WAVES FROM A SOLID SPHERICAL PROBE IN A WARM ISOTROPIC PLASMA
[illegible]
Rad. Sci., Paper 3S1687

0773 Remote sensing
RETRIEVAL OF TEMPERATURE AND COMPOSITION FROM NIMBUS 7 [illegible]
C. D. Rodgers [illegible]
[illegible]
J. Geophys. Res., Atmos., Paper 3D1686

0773 Remote Sensing
THE EARTH RADIATION BUDGET DERIVED FROM THE NIMBUS-7 ERB EXPERIMENT
Herbert Jacobowitz [illegible]
[illegible]
J. Geophys. Res., Ocean, Paper 3C1594

0780 Scattering
REFLECTION AND SCATTER FORMULA FOR ANISOTROPICALLY TURBULENT AIR
E. E. Gossard [illegible]
[illegible]
Rad. Sci., Paper 3S1706

Geodesy and Gravity

1910 Crustal Movements
HORIZONTAL STRAIN ACROSS THE WASATCH FRONT NEAR SALT LAKE CITY, UTAH
R. A. Snay [illegible]
[illegible]
J. Geophys. Res., Earth, Paper 3B1705

1950 Relations of gravity observations to tectonics and isostasy
A DETAILED VIEW OF THE SOUTH PACIFIC FROM SATELLITE ALTIMETRY
D. T. Sandwell (National Geodetic Survey, Charting and Geodetic Services, National Ocean Service, NOAA, Rockville, Md. 20852)
[illegible]
J. Geophys. Res., Earth, Paper 3B1739

Exploration Geophysics

0910 Computer Applications
SYNTHETIC SEISMOGRAMS IN ATTENUATING MEDIA
[illegible]
GEOPHYSICS, VOL. 48, NO. 12

0930 Seismic methods
REVERSE TIME MIGRATION
[illegible]
GEOPHYSICS, VOL. 48, NO. 11

0930 Seismic methods
COMMENT TO "DETERMINATION ON IN-SITU ATTENUATION FROM FULL WAVEFORM ACOUSTIC LOGS" BY CH. H. CHENG, M. N. TOKSÖZ AND M. E. WILLIS
L. Engelhard (Institut für Geophysik und Meteorologie, Technische Universität, D-3300 Braunschweig, F. R. Germany), Th. Groß and P. Baupert
[illegible]

Hydrology

3110 Erosion and Sedimentation (Channel Stability)
EXTREMAL HYPOTHESES FOR RIVER REGIME: AN ILLUSION OF PROGRESS
G. A. Griffiths [illegible]
[illegible]
Water Resour. Res., Paper 3W1647

3125 Glaciology
JAKOBSHAVNS GLACIER DRAINAGE BASIN: A BALANCE ASSESSMENT
R. A. Bindschadler [illegible]
[illegible]

3150 Groundwater [illegible]
[illegible]
Water Resour. Res., Paper 3W1655

3160 Runoff and Streamflow
DISAGGREGATION PROCEDURES FOR GENERATING SERIALLY CORRELATED FLOW VECTORS
J. R. Stedinger [illegible]
[illegible]
Water Resour. Res., Paper 3W1651

3180 Water Quality (Stream chemistry)
EFFECTS OF CLEARCUTTING AND SLASHBURNING ON STREAMWATER CHEMISTRY AND WATERSHED NUTRIENT BUDGETS IN SOUTHWESTERN BRITISH COLUMBIA
[illegible]
Water Resour. Res., Paper 3W1649

3199 General (Water Use)
CASCADE MODEL OF MONTHLY MUNICIPAL WATER USE
[illegible]
Water Resour. Res., Paper 3W1669

[illegible]
Water Resour. Res., Paper 3W1712

Meteorology

3710 Boundary layer structures and processes
ATMOSPHERIC BOUNDARY-LAYER MODIFICATION, DRAG COEFFICIENT, AND SURFACE HEAT FLUX IN THE ANTARCTIC MARGINAL ICE ZONE
E. L. Andreas [illegible]
[illegible] MIZ. Using the rising of the inversion and ABL similarity theory, we estimated the change in the neutral stability drag coefficient, C_D, across the MIZ. C_D increased from its open ocean value, 1.2×10^{-3}, at the ice edge to 4.0×10^{-3} at 80-90% ice concentration. We present an equation for this dependence of drag on ice concentration that should be useful for modeling the surface stress in marginal ice zones. (Marginal ice zone, drag coefficient, atmospheric boundary layer, heat exchange).
J. Geophys. Res., Oceans, Paper 3C1716

3720 Climatology
MICROCLIMATE AT ARCTIC TREELINE II. SOIL MICROCLIMATE OF TUNDRA AND FOREST
W.R. Rouse (Geography Department, McMaster University, Hamilton, Ontario, Canada, L8S 4K1)
Forest and tundra soils display distinctive microclimates for a climatically normal year at Churchill. Forest soils are substantially warmer in the active layer than those of the tundra but the tundra active layer is deeper. Forest soils are much wetter than those of the tundra. This results from the deep winter snow pack which provides abundant meltwater to already thawed soils. The soils remain wet throughout the year and the large latent heat release delays the freezing of forest soils until a snow pack is established. As a result, soils stay relatively warm throughout winter and thaw rapidly and deeply before snow pack melting in the spring. The thaw period in the tree rooting zone is about 6 months compared to 4 months at the same depth in tundra.
The magnitude of soil heat storage is large, comprising 18 and 16% of net radiation in tundra and forest respectively during the thaw season. During freeze-back it is the dominant heat exchange process. Between 80 and 90% of the total soil heat storage is involved in the latent heat exchange accompanying thawing and freezing. Soil heat flux plates strongly underestimate the ground heat exchange and are unreliable in permafrost terrain. (Soil microclimate, tundra and forest).
Water Resour. Res., Paper 3W1650

3720 Climatology
MICROCLIMATE AT ARCTIC TREELINE I. RADIATION BALANCE OF TUNDRA AND FOREST
W.R. Rouse (Geography Department, McMaster University, Hamilton, Ontario, Canada, L8S 4K1)
Components of the radiation balance were measured or calculated for upland tundra and adjacent open spruce forest for the period from April to September 1979 at Churchill, Manitoba, which is positioned near the tree line and which is underlain by continuous permafrost.
Because of deep winter snow accumulations, snow melt in the forest lags behind that of the tundra by almost a month. The tundra undergoes a step wise change in albedo from 0.78 to 0.09 over a period of a few days of final snow melt. Its albedo is constant over the summer. On clear days for both surfaces there is a strong diurnal pattern of raised albedos in morning and evening due to specular reflection. On cloudy days there is almost no daily change.
The tundra radiative surface temperatures are almost always larger than those of the forest, but differences decrease systematically as the summer progresses. In late winter, on clear days, the forest canopy averages 6.6°C warmer than the surrounding air and 12.6°C warmer than the snow beneath. This results from an absorption of incident and reflected solar radiation by the non-transpiring trees. In winter the forest canopy serves as a convective and radiative heat source to the snow beneath. This hastens snow melt in late winter.
The forest has a larger net radiation than the tundra at all times but this is particularly pronounced with the large solar radiation input of late winter before any snow melt takes place. Destruction of the forest will lead to a greatly modified radiation and surface temperature regime. (Low Arctic, radiation balance, treeline).
Water Resour. Res., Paper 3W1651

3720 Climatology
MICROCLIMATE AT ARCTIC TREELINE III. THE EFFECTS OF REGIONAL ADVECTION ON THE SURFACE ENERGY BALANCE OF UPLAND TUNDRA
W.R. Rouse (Geography Department, McMaster University, Hamilton, Ontario, Canada, L8S 4K1)
Energy balance components of net radiation, ground heat flux and latent and sensible heat fluxes for upland tundra near the Hudson Bay coast at Churchill were measured continuously between April 25 and October 6, 1979. The measurements indicate a strong regional advective effect. In the premelt period during cold onshore winds, net radiation was very small and the other energy balance components were negligible. For offshore warmer winds net radiation was large as were the other fluxes, especially the ground heat flux. In the post-melt period with cold onshore winds, sensible heating of the atmosphere was large and heating of the ground was suppressed. For offshore winds, ground heating was large and atmospheric heating was suppressed. The magnitude of net radiation and the latent heat flux were little affected by wind direction in the post-melt period. The implications of the results are discussed with respect to the potential effects of climatic cooling and warming. (Regional advection, energy balance, tundra).
Water Resour. Res., Paper 3W1649

3720 Climatology
SEASONAL VARIATION IN WIND SPEED AND SEA STATE FROM GLOBAL SATELLITE MEASUREMENTS
D. T. Sandwell (National Geodetic Survey, Charting and Geodetic Services, National Ocean Service, NOAA, Rockville, Md. 20852), R. W. Agreen
The GEOS-3 altimeter, which collected data intermittently for nearly four years, has measured significant wave heights and surface wind speeds over most of the world's oceans. Using these data we have constructed contour maps of spatial variations in sea state and wind speed for winter and summer. To obtain reliable averages in the southern oceans we low-pass filtered the data using a two-dimensional Gaussian filter with a half-width of 150 km. The wind speed maps show that the zonal surface wind patterns, such as the westerlies, the horse latitudes, the trade winds, and the doldrums, shift south by about 10° between winter and summer. As expected, the highest wind speeds and sea states occur during the winter months in the mid-latitudes, 30°–60°. The most striking feature of the maps, however, is the large asymmetry in the summer to winter variation between the two hemispheres. The largest seasonal variations in sea state and wind speed occur in the northern hemisphere oceans and especially in the North Atlantic where there is almost a factor of two variation. In contrast, the summer to winter variation in wind speed and sea state in the southern hemisphere oceans is relatively small. For example, the summer to winter increase in wind speed at 55°S is less than 10 percent while at 50°N it is more than 50 percent. This differing variability can be attributed to the asymmetric distribution of continental area between the two hemispheres and the low effective heat capacity of the continents relative to the oceans. (Wave height, wind speed, seasons, altimeter)
J. Geophys. Res., Oceans, Paper 3C1719

3735 Electrical Phenomena
CORRELATED OBSERVATIONS OF THREE TRIGGERED LIGHTNING FLASHES
V.P. Idone (Dept. of Atmos. Science, State University of New York at Albany, Albany, New York 12222), R.E. Orville, P. Hubert, L. Barret, and A. Eybert-Berard
A cooperative analysis of three triggered lightning flashes initiated during TRIP '81 at Langmuir Laboratory, New Mexico, has resulted in the determination of three-dimensional return stroke propagation speeds and peak currents for 56 subsequent strokes. We find a nonlinear relationship between the return stroke propagation speed and the stroke peak current that is qualitatively similar to that proposed by both Lundholm and Wagner. A nonlinear correlation is also found between the return stroke propagation speed and the dart leader propagation speed for 32 strokes. Linear correlation coefficients are evaluated for the following quantities: dart leader propagation speed and ensuing return stroke peak current (32 strokes; r=0.84); stroke peak current and interstroke interval (69 strokes; r=0.57); return stroke propagation speed and interstroke interval (56 strokes; r=0.49); dart leader propagation speed and interstroke interval (32 strokes; r=0.43). The weak positive correlation found between the dart leader propagation speed and the interstroke interval contradicts previous corresponding natural lightning observations. The mean three-dimensional return stroke propagation speed for 56 strokes is 12×10^7 m/s with a range of 6.7×10^7 m/s to 17×10^7 m/s; the mean three-dimensional propagation speed found for 32 dart leaders is 20×10^6 m/s with a range of 9.5×10^6 m/s to 43×10^6 m/s. The mean dart length measured is 50 m with a range of 15 m to 90 m. In two of the three flashes, the downward propagating dart leaders appear to meet upward propagating streamers at heights of approximately 20 m and 30 m, respectively. (Lightning)
J. Geophys. Res., Atmos., Paper 3D1755

3735 (Electrical phenomena)
CHARACTERISTICS OF LIGHTNING VHF RADIATION NEAR THE TIME OF RETURN STROKES
C. O. Hayenga (Geophysical Research Center, Physics Department, New Mexico Institute of Mining and Technology, Socorro, New Mexico, 87801)
Using a crossed baseline interferometer, lightning VHF source positions correlated in time with electric field change measurements have been obtained. We present data in this paper showing azimuth and elevation pictures with high time resolution of the VHF (34.3 MHz) radiation for events near the time of return strokes. From their common characteristics we infer spatial and temporal features of these processes. No radiation was seen that could be attributed to the return stroke wavefront itself. Radiation from stepped leaders continued up to and, in some cases, after initiation of the first return stroke. A strong burst of radiation often followed the first return stroke. Strong radiation began before subsequent return strokes, coinciding with the electric field change usually associated with the dart leader. The end of the radiation was independent of the return stroke. The source of this radiation was a well-defined region within the cloud. A second burst often followed the return stroke located in the same region as that prior to the stroke. Sources from stroke to stroke showed horizontal displacement with little apparent change in elevation. (Lightning, RF Location).
J. Geophys. Res., Atmos., Paper 3D1710

3735 Electrical Phenomena
REDUCTION OF THUNDERSTORM ELECTRIC FIELD INTENSITY PRODUCED BY CORONA FROM A NEARBY OBJECT
B. Vonnegut, Atmospheric Sciences Research Center, State University of New York at Albany, Albany, New York 12222
Measurements with an electric field mill beneath a thundercloud show that space charge produced by corona from a surrounding, horizontal, fine-wire antenna that is connected to the earth greatly reduces the electric field intensity.
J. Geophys. Res., Atmos., Paper 3D1698

3740 General circulation
OBSERVATIONS OF CH_4 AND N_2O BY THE NIMBUS 7 SAMS: A COMPARISON WITH IN SITU DATA AND TWO DIMENSIONAL NUMERICAL MODEL CALCULATIONS
J. A. Pyle (SERC/Rutherford Appleton Laboratory, Chilton, Didcot, Oxon OX11 0QX, UNITED KINGDOM), R. L. Jones
Monthly mean, zonal mean measurements of CH_4 and N_2O for 1979 made by the stratospheric and mesospheric sounder (SAMS) on the Nimbus 7 satellite are presented for the first time. Comparison with in situ and other available data confirms a general pattern of mixing ratios decreasing with height and of maxima, at a given pressure level, in low latitudes. The SAMS data, by virtue of its extensive coverage, reveals new features. These include during certain months a 'double peak' when, along a constant pressure surface, mixing ratio maxima are found in low latitudes of both hemispheres with a local minimum at the equator. In the upper stratosphere are found regions of weak and strong horizontal gradients. Comparison with a two dimensional model shows many areas of agreement, especially for CH_4, and the model is used to interpret atmospheric behaviour. The model overestimates in terms of a possible underestimation of the photochemical sink. We believe strongly, however, that uncertainties in transport representation cannot be ruled out.
J. Geophys. Res., Atmos., Paper 3D1644

3790 Techniques (Precipitation Measurement)
A REVIEW OF MULTIPARAMETER RADAR OBSERVATIONS OF PRECIPITATION
R.R. Rogers (Meteorology Department, McGill University, Montreal, Canada, H3A 2K6)
This paper reviews the methods that have been used in the field of radar meteorology to obtain information about precipitation by measuring quantities in addition to the radar reflectivity. Its purpose is to set the stage for papers on current research presented at the URSI Symposium on Multiple-Parameter Radar Measurements, held in Bournemouth, UK, in August 1982, by outlining earlier developments and problems. Emphasis is placed on differential reflectivity measurements (by dual polarization or dual wavelength methods), Doppler measurements, and depolarization measurements, because these are the techniques figuring prominently in the papers of the Symposium.
Rad. Sci., Paper 3S0898

Mineralogy, Petrology, and Crystal Chemistry

4270 Properties of minerals
OXYGEN SELF DIFFUSION IN QUARTZ UNDER HYDROTHERMAL CONDITIONS
Paul F. Dennis (Department of Geology, Imperial College, LONDON SW7 2BP, U.K.)
Oxygen self diffusion, D_{ox}, has been monitored in single crystal quartz in the temperature range 515–850°C under hydrothermal conditions. In the beta field, between 700–850°C, the data are represented by two linear Arrhenius relations for transport parallel and perpendicular to c;

	D_0 (m^2s^{-1})	ΔH (kJ mol^{-1})
∥c	2.09×10^{-11}	138.54
⊥(10$\bar{1}$0)	3.16×10^{-10}	203.72

At 700°C, in the total pressure range 11.5–100 MPa, D_{ox} is independent of water and oxygen fugacities between the Ni-NiO and Fe_3O_4-Fe_2O_3 buffers. The results are consistent with diffusion via a simple charged vacancy mechanism under an extrinsic point defect regime. Further experiments are required to confirm the nature of the mobile oxygen defect.
A key aspect of the results is the observation that at the low water fugacities of the present experiments a hydrogen containing defect appears to play no role in the oxygen transport mechanism. This is in contrast to other published sets of data and leads directly to the requirement for detailed interlaboratory comparisons. (Diffusion, point defects, quartz).
J. Geophys. Res., Earth, Paper 3B1610

Oceanography

4706 Boundary layer and exchange processes
OBSERVATIONS AND SIMULATION OF A BOTTOM EKMAN LAYER ON A CONTINENTAL SHELF
T. D. Dickey (Department of Geological Sciences, University of Southern California, Los Angeles, California, 90089-0741), J. C. Van Leer
A numerical model was used to simulate the bottom Ekman layer of a continental shelf region. The basis for the model was the Mellor and Yamada level 2 1/2 turbulence closure scheme. Conservation equations for momentum, turbulent kinetic energy, and turbulent length scale were utilized in the model. The model was used to simulate data taken from a Cyclesonde mooring on the Peruvian continental shelf in May 1976 as part of the Joint II Coastal Upwelling Ecosystems Analysis program. The Cyclesonde provided mean horizontal velocity, temperature, salinity, and pressure data. An intense poleward undercurrent drove the bottom flow regime. The most striking feature of the data was the clockwise Ekman veering of velocity vectors as the bottom was approached. A 48h period was chosen for the model simulations. The vertical speed profile (48h mean) simulated by the model fell within the error bars of the data. The corresponding Ekman spiral display of the model results also showed good agreement with the observations. (Ekman layer, bottom boundary layer, Cyclesonde, numerical model).
J. Geophys. Res., Oceans, Paper 3C1717

4799 General (Wind-driven currents)
A THEORETICAL RESPONSE OF A WIND-DRIVEN OCEANIC SURFACE LAYER AND ITS APPLICATION TO THE ANALYSIS OF LAGRANGIAN MEASUREMENTS
J.K. Lewis (Science Applications, Inc., 4348 Carter Creek Parkway, Bryan, Texas, 77802) and W.W. Denner
An analytical response of an oceanic surface layer to wind stress is given for those situations in which horizontal pressure and stress gradients are neglected. The vertically averaged velocity $\bar{U}$ of the surface layer is seen to be the sum of time-damped inertial oscillations. For the wind stress τ_s that is relatively constant, the analytical solution reduces to $\bar{U} = A\tau_s$, with both the Coriolis and bottom friction effects included in the matrix A. An empirical analysis method is presented which compares the theoretical transports based on wind data with actual velocities as determined by Lagrangian observations. This method can be used to determine the effect of bottom friction, the depth of the wind-driven surface layer, and the time-integrated effect of horizontal pressure and stress gradients. An example is presented using wind and position data collected on the Arctic ice pack during the summer of 1975. (Surface currents, wind forcing, Lagrangian measurements, ice motion).
J. Geophys. Res., Oceans, Paper 3C1718

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Particles and Fields—Interplanetary Space

5320 Cosmic ray effects (Lunar rocks)
COSMIC RAY EXPOSURE HISTORIES OF APOLLO 14, APOLLO 15, AND APOLLO 16 ROCKS
O. Eugster (Physikalisches Institut, University of Bern, 3012 Bern, Switzerland), F. Eberhardt, J. Geiss, N. Grögler, M. Jungck, F. Meier, M. Mörgeli, and F. Niederer

J. Geophys. Res., Earth, Paper 3B5007

Particles and Fields—Ionosphere

5515 Aurorae
PREDICTION OF PHOTON YIELDS FOR PROTON AURORAE IN AN N_2 ATMOSPHERE

J. Geophys. Res., Space, Paper 3A1685

5530 High latitude ionospheric currents

5535 Interactions between waves and particles
A SEARCH FOR THE PLASMA PROCESSES ASSOCIATED WITH PERPENDICULAR ION HEATING
P. M. Kintner (School of Electrical Engineering, Cornell University, Ithaca, New York, 14853), David J. Gurney

5540 Ion densities and temperatures

J. Geophys. Res., Space, Paper 3A1703

5570 Total Electron Content
ELECTRON CONTENT MEASUREMENTS WITH GEODETIC DOPPLER RECEIVERS

5580 Wave Propagation
STATISTICAL CHARACTERIZATIONS OF EQUATORIAL SCINTILLATION IN THE ASIAN REGION

regularities. Autocorrelation calculation provided a characteristic coherent interval, τ. The study suggests that equatorial ionospheric irregularities in the F-region, with subkilometer sizes in the evening hours after local sunset, are the main cause of the gigahertz scintillations observed. The spectra of the irregularities appear to be the power-law type, with spectral indices, p, that generally have values greater than 4. The characterizations of S_4, ν, and τ for both the Pacific and Indian Ocean Region links provide an important basis for improved modeling of ionospheric scintillation phenomena in the Asian Region. (Gigahertz fluctuation, equatorial scintillation).
Rad. Sci., Paper 3S1734

5590 Instruments and Techniques
AN ATTEMPT TO MEASURE THE FIELD-ALIGNED DRIFT VELOCITY OF THERMAL ELECTRONS IN THE AURORAL IONOSPHERE
L. R. O. Storey (STAR Laboratory, Stanford Electronics Laboratories, Stanford, California 94305), and J. Thiel
A medium-frequency (0.7 - 1.5 MHz) mutual-impedance probe was flown on three rockets in the auroral ionosphere, for the purpose of measuring the field-aligned drift velocity of the thermal electrons. Detailed results are presented from one of these experiments, in which a sensitivity of the order of 1% of the electron thermal velocity was achieved. Downward electron drifts were indicated, but their high apparent velocities cast doubt on their authenticity. Data from this and the other two experiments suggest that the probe was being perturbed by the payload body. This problem needs to be solved, and the sensitivity improved by an order of magnitude, in order for the probe to become a useful measuring instrument. (Mutual-impedance probes, lower oblique resonance, field-aligned currents)
J. Geophys. Res., Blue, Paper 3A1606

5590 Techniques
MITHRAS: A BRIEF DESCRIPTION
O. de la Beaujardière (Radio Physics Laboratory, SRI International, Menlo Park, California 94025), J. Holt, R. H. Wand, W. L. Oliver, P. Bauer, M. Blanc, C. Senior, D. Alcaydé, G. Caudal, J. Foster, E. Nielsen, and R. Heelis
Between May 1981 and June 1982, an intensive campaign of thirty-three coordinated observations was carried out using the three incoherent-scatter radars capable of probing the auroral zone. During this period the groups operating the Dynamic Explorer satellites and the STARE radar made special efforts to acquire data coincident with the radar observations. The objective of these MITHRAS experiments and subsequent analysis is to further our understanding of the interactions of the magnetosphere, the ionosphere, and the thermosphere, with special emphasis on local time/universal time variations. Three experimental modes with different time resolution and spatial coverage, were used to examine different aspects of these interactions. The analysis of the extensive data set involves collaboration among groups of experimenters as well as between experimenters and theoreticians. (Incoherent scatter, high latitude, plasma convection, longitudinal effects.)
Rad. Sci., Paper 3S1740

5599 General (Thermal Electron Heating)
THERMAL ELECTRON HEATING RATE, A DERIVATION
W. R. Hoegy (Code 961, GSFC, Greenbelt, MD 20771)
A formula for the thermal electron heating rate is derived from the kinetic equation using the electron-electron collision operator as given by the unified theory of Kihara and Aono. The derived heating rate Q_e is the sum of three terms, $Q_e = Q_p + S + Q_{int}$, which are respectively: 1) primary electron production term – heating from newly created electrons that have not suffered collisions; 2) energy surface term – energy transfer between Maxwellian and tail electrons at the transition energy, E_T, of these two populations; and 3) integral term – heating of Maxwellian electrons by tail electrons at energies > E_T. The new heating rate can differ significantly from electron heating rates used in the published literature. Numerical examples are given. (Electron Heating Rate, Electron Energy Balance, Photoelectron Flux).
J. Geophys. Res., Space, Paper 3A1701

Particles and Fields—Magnetosphere

5736 Magnetic Tail
OBSERVATIONS OF MULTIPLE ION BEAMS IN THE MAGNETOTAIL: EVIDENCE FOR A DOUBLE H+ POPULATION
N. Candidi (Istituto Fisica Spazio Interplanetario, CNR, C.P. 27, 00044 Frascati, (Roma) Italia), and S. Orsini
One hour of ISEE 2 plasma experiment data shows the coexistence of ionospheric oxygen ions and protons with solar wind alphas and protons in the geomagnetic tail low latitude boundary layer. The two proton populations have different angular distributions. This is explained simply, on the basis of the assumption that the two populations were injected on magnetospheric field lines at different altitudes. (Ion beams, conical distributions).
J. Geophys. Res., Space, Paper 3A1465

5736 Magnetic Tail
THE STRUCTURE OF THE PLASMA SHEET-LOBE BOUNDARY IN THE EARTH'S MAGNETOTAIL
S. Orsini (IFSI/CNR, C.P. 27, 00044 Frascati, Roma, Italy), M. Candidi, V. Formisano, H. Balsiger, A. Ghielmetti, K. W. Ogilvie
The structure of the magnetotail plasma sheet-plasma lobe boundary is studied by observing the properties of tailward flowing O^+ ion streams. These have been detected by the ISEE-2 plasma experiment and the ISEE-1 ion composition experiment inside the boundary during three time periods in April 1978. Data from the ISEE-1 electron spectrometer are used to define the location of the boundary.
The density of the O^+ ion streams has a relative maximum and their flow velocity has a relative minimum at the boundary.
The XY drift velocity GSE component across the local magnetic field changes its sign at the boundary, indicating a reversal of the E_z electric field component. These changes are consistent with the topology of the electric field in the tail as mapped from the ionosphere.
J. Geophys. Res., Space, Paper 3A1448

5745 Magnetospheric configuration
THE 40 KeV ELECTRON DURABLE TRAPPING REGION
J. Feynman (Department of Physics, Boston College, Chestnut Hill, MA, 02167), D. A. Hardy and E. G. Mullen (Air Force Geophysics Laboratory, Hanscom AFB, Bedford, MA 01731)
The position and extent of the region in which electrons with energies less than 40 keV are durably trapped in the nightside magnetosphere is found for both normal and disturbed geomagnetic conditions using data from the P78-2 (SCATHA) satellite. The region of the magnetosphere from 5.3 to 7.9 Re was studied. In this region neither solar-magnetic nor geocentric-solar magnetospheric coordinates order the data satisfactorily. A new coordinate system called composite coordinates is introduced. It takes account of the fact that this region of the magnetosphere is strongly influenced by both the Earth's dipole field and the direction of the solar wind. In composite coordinates when Kp≤4, 40 keV electron fluxes are almost continuously present in a region centered on the equatorial plane and 1.2 Re in half width. At larger composite coordinate latitudes there is another region more than 1 Re thick within which 40 keV electron fluxes routinely appear and disappear on time scales of one hour as the trapping boundary actively moves over the satellite. We have no evidence that SCATHA ever entered the tail lobes where no particles are trapped. When Kp≥6- the region in which 40 keV electron fluxes were always present moved earthward and/or thinned but remained ordered in composite coordinates. We suggest that the new coordinate system will be useful for ordering other data sets taken in this region of the magnetosphere. (dropouts, keV electron trapping, injections, hinging region).
J. Geophys. Res., Space, Paper 3A1627

5745 Magnetospheric configuration
RING COUPLING MODEL: IMPLICATIONS FOR THE GROUND STATE OF THE MAGNETOSPHERE
N. U. Crooker (Department of Atmospheric Sciences, UCLA, Los Angeles, California 90024), G. L. Siscoe, E. A. Doyle and W. J. Burke
The ring coupling model predicts that the radius of the polar cap remains appreciable down to very small values of the transpolar potential Φ and then decreases rapidly to zero as Φ goes to zero. Electric field data from the S3-2 spacecraft are shown to be consistent with the prediction, in that both the theory and the data show a weak dependence of polar cap radius on potential in the observed range. This behavior leads to theoretical insights about the ground states of the magnetosphere. Because the theoretical ground state (Φ = 0) has no polar cap, the model implies that the finite polar cap observed after extended periods of northward IMF is the result of a small potential being generated continually by the solar wind. If it is assumed that this potential is generated on closed magnetic field lines by some viscous-like interaction, and the bulk of potential is generated sporadically by magnetic merging, then the model implies that the polar cap retains open flux during extended periods of northward IMF and that it does so because of the presence of the potential generated by the viscous-like interaction. (Ground state, polar cap).
J. Geophys. Res., Space, Paper 3A1662

5755 Plasma instabilities
ON THE STABILITY OF THE IONOPAUSE OF VENUS
R. C. Elphic (Laboratory for Planetary Atmospheres, NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771 USA), A. I. Ershkovich
We examine the stability of the Venus ionopause in light of the importance of gravitation and curvature. Using a one fluid approximation for the equation of motion of the plasma, and ignoring the effects of neutrals, we obtain a dispersion relation which includes the effects of magnetic field, sheared plasma flow, bouyancy, centrifugal force and magnetic tension due to boundary curvature. We find that bouyancy acts to neutralize the flute instability. As expected, the Kelvin-Helmholtz mode is the dominant instability over most of the dayside ionopause. The expected growth times of this mode are short compared to the wave convection time over the boundary; the waves can grow and saturate quickly, producing a turbulent boundary which may affect electrodynamic coupling between the solar wind and ionospheric plasmas. (Venus, ionopause, flute instability, Kelvin-Helmholtz instability).
J. Geophys. Res., Space, Paper 3A1700

5755 Plasma instability
ION-BEAM-DRIVEN ELECTROSTATIC HYDROGEN CYCLOTRON WAVES ON AURORAL FIELD LINES
H. Okuda and M. K.-I. Nishikawa (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544).
It is shown analytically and by means of plasma numerical simulations that the large amplitude hydrogen cyclotron waves on auroral field lines near 1 R_E altitude may be excited by upward flowing ion beams rather than by field-aligned currents. The large amplitude electric field near ω ≈ Ω is identified as the ion gyro-harmonic waves of the beam ions observed in the frame of background ions and, therefore, such a wave exists only when the instability is excited by ion beams. Both the theory and numerical simulations support the conclusion. (Hydrogen cyclotron waves, ion beams).
J. Geophys. Res., Space, Paper 3A1568

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5755 Plasma Instabilities
ELECTROSTATIC ION (HYDROGEN) CYCLOTRON AND ION ACOUSTIC WAVE INSTABILITIES IN REGIONS OF UPWARD FIELD-ALIGNED CURRENT AND UPWARD ION BEAMS
J. Bergmann (Space Sciences Laboratory, University of California, Berkeley, CA 94720)
An investigation is made into the stability of electrostatic hydrogen ion cyclotron and ion acoustic waves in a model plasma where an ion beam, population 2, and oppositely directed drifting electrons pass through a stationary ion background, population 1. The excited wave properties are then compared to the characteristics of the unstable modes observed on the S3-3 satellite. Three temperature regimes are studied: 1) $T_e \approx T_{12} \gg T_{11}$, 2) $T_{12} \geq T_e > T_{11}$ and 3) $T_e > T_{11} > T_{12}$. It is found that the ion beam acts as a free energy source only in regime 1. This regime is also highly unstable to the electrons as a free energy source. Unstable modes in regimes 2 and 3 seem to best satisfy the EHC properties at $1R_E$. In this case, the electrons are the free energy source, the beam supplies damping.
J. Geophys. Res., Space, Paper 3A1692

5775 (Trapped particles)
THE RADIAL DISTRIBUTION OF RADIATION BELT PROTONS
V. Jentsch, Institut für Reine und Angewandte Kernphysik der Christian-Albrecht-Universität Kiel, 2300 Kiel, FR Germany
We present quasi-analytic solutions to the proton diffusion equation, with energy degradation and charge exchange losses included. The transport mode is modeled as $D = K^{-4}L^{E}(K,L)$, where M, K and L are the adiabatic invariants, and E refers to the spectral index of the fluctuating electric field. At the outer boundary, say L = 7, a distribution function of the form f ∝ exp − $[\alpha N_0(E)]^{\nu}$ is maintained; at the inner boundary (L ≈ 1), f is required to vanish. We find that
(1) the diffusion flux is directed outwards, when energy loss and charge exchange are in approximate balance
(2) the shape of the proton flux is strongly affected by the spectral index of the fluctuating fields
(3) the proton flux exhibits both positive and negative gradients with respect to energy
(4) the anisotropy of the proton flux increases with decreasing L-value, and may pass through a minimum with respect to energy.
J. Geophys. Res., Space, Paper 3A1708

5780 Wave propagation
A MECHANISM FOR THE IPDP PULSATIONS
L.C. Lee (Geophysical Institute, University of Alaska, Fairbanks, Alaska, 99701, and Y.C. Kwok.
The IPDP pulsations are assumed to be generated in the region where the low-density energetic protons (10 - 100 keV) injected during substorms encounter the high-density plasmasphere. The increase in the wave frequency during the IPDP events is proposed to be caused by the enhanced dispersion of the wave velocity due to the presence of the helium ions in the plasmasphere. In the presence of the helium ions, the variation in the traveling time of the unstable waves is found to be typically 5 – 20 min, which is comparable to the duration of some of the observed IPDP events. (Pulsations, instability, substorms).
J. Geophys. Res., Space, Paper 3A1736

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5799 General (Shuttle Glow)
ON THE SHUTTLE GLOW (THE PLASMA ALTERNATIVE)
K. Papadopoulos (Science Applications, Inc., McLean Virginia 22102)
It is shown that the anomalous glow observed in the recent space shuttle flights can be attributed to a combination of beam plasma discharge and critical ionization phenomena. While the shuttle velocity (~8 km/sec) is below the critical ionization velocity, which for oxygen is 12.7 km/sec, specular reflection of a small fraction (2-3%) of ambient ions forms an ion beam with velocity 16 km/sec, making up for the energy deficit in the critical ionization velocity phenomenon. The wave activity observed is consistent with this model. (Glow, critical ionization velocity, plasma neutral gas interactions).
Rad. Sci., Paper 3S1677

Physical Properties of Rocks

6110 Physical Properties of Rocks
A NOTE ON THE RATE SENSITIVITY OF FRICTIONAL SLIDING OF WESTERLY GRANITE
P. Solberg and J. D. Byerlee (U.S. Geological Survey, 345 Middlefield Road, MS/77, Menlo Park, CA 94025)
The frictional sliding of simulated faults containing crushed Westerly granite was studied in a series of constant stepped velocity experiments. Confining pressures were varied from 1 to 300 MPa and sliding velocity varied from .00733 to 7.33 μm/s. The strain-rate sensitivity (B), that is, the slope of the frictional stress change (Δμ) with the logarithm of the change in velocity ($\log_{10}V_2/V_1$) was found to be low and pressure dependent, increasing with increased confining pressure to a maximum of approximately .01 at 300 MPa confining pressure.
J. Geophys. Res., Earth, Paper 3B1631

6199 General (Acoustic Anisotropy)
CALCITE FABRIC AND ACOUSTIC ANISOTROPY IN DEEP-SEA CARBONATES
C.H. Schaftenaar (Dept. of Geophysics, Texas A&M University, College Station, TX 77843) and R.L. Carlson
Several investigators have proposed that compressional-wave anisotropy in indurated, deep-sea carbonates is caused by a preferred orientation of calcite c-axes normal to bedding. To test this hypothesis, we have used X-ray pole figure goniometry to measure calcite fabrics in three anisotropic, calcareous sediment samples from DSDP Hole 516F, on the Rio Grande Rise. Anisotropy in these samples ranges from 3.4 to 12.0 percent. The suggested concentration of c-axes is present, but very weak; concentrations of c-axes normal to bedding are in the range 1.1 to 1.3 percent per 1 percent area. We used the Voigt-Reuss-Hill averaging scheme to calculate velocities from the X-ray fabric data, and found that even in nonporous, pure carbonate rocks, having the observed concentrations of c-axes, the acoustic anisotropy would be less than 1 percent. We conclude that preferred orientation of calcite is not a significant contributor to compressional-wave anisotropy in deep-sea sediments.
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COMPARISON OF YAMATO AND VICTORIA LAND POLYMICT EUCRITES: A VIEW FROM MINERALOGICAL AND ISOTOPIC STUDIES
H. Takeda (Mineralogical Institute of Science, Hongo, Tokyo 113, Japan), J. L. Wooden, H. Mori, J. S. Delaney, M. Prinz, L. E. Nyquist
New interior samples of four Yamato polymict eucrites (Y74159, Y74450, Y75011, and Y75015) have been studied by electron microprobe, transmission electron microscope, and X ray diffraction techniques, and compared with several samples of the Victoria Land polymict eucrites. These same samples have been analyzed using Rb-Sr and Nd-Sm isotopic systematics.
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6360 Meteoritics
BRACHINA: A NEW TYPE OF METEORITE, NOT A CHASSIGNITE
C. E. Nehru (Department of Mineral Sciences, American Museum of Natural History, New York, NY 10024), M. Prinz, J. S. Delaney, G. Dreibus, H. Palme, B. Spettel and H. Wanke
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